DOCUMENT RESUME

ED 431 700
SO 030 911

AUTHOR	Vandenberg-Daves, Jodi, Comp.; Gorn, Cathy, Ed.
TITLE	Science, Technology, Invention in History: Impact, Influence, Change. National History Day 1999, Teacher Guide [and] Contest Guide.
INSTITUTION	Maryland Univ., College Park.
PUB DATE	1999-00-00
NOTE	89p.
AVAILABLE FROM	National History Day, 0119 Cecil Hall, University of Maryland, College Park, MD 20742; Tel: 301-314-9739.
PUB TYPE	Guides - Classroom - Learner (051) -- Guides - Classroom - Teacher (052) -- Reports - Descriptive (141)
EDRS PRICE	EDRS Price MF01 Plus Postage. PC Not Available from EDRS.
DESCRIPTORS	Class Activities; Critical Thinking; Elementary Secondary Education; History Instruction; Internet; *Inventions; Learning Activities; Science Instruction; *Scientific and Technical Information; Student Research; *Technological Advancement; Thematic Approach; *United States History; *World History
IDENTIFIERS	Historic Sites; *National History Day

ABSTRACT

The theme for National History Day during 1998-99 school year is "Science, Technology, Invention in History: Impact, Influence, Change. National History Day competition has two divisions based on school grade: junior division--grades 6, 7, and 8; and senior division--grades 9, 10, 11, and 12. This teacher guide provides teachers with classroom materials to help students gain an understanding of the historical, economic, and social ramifications of science, medicine, engineering, computers, technology, and related subjects bridging the gap between history and the sciences. Young people need to understand that although technology depends upon mathematics and science, it responds to and is shaped by human values and that these values vary from time to time and place to place. The booklet includes teaching strategies for using National History Day in the classroom, lessons on several topics related to the theme, possible topic suggestions for student research, and a selective bibliography of resources. Lessons in the booklet assist students in focusing on a topic and understanding its significance in history through the use of primary sources. The booklet is divided into the following sections: (1) "Introduction: What Is National History Day?"; (2) "Ideas and Materials: Teaching about Science, Technology, Invention in History"; (3) "Theme Narrative, Topic Ideas and Bibliography: Science, Technology, Invention in History"; (4) "Getting Caught Up in the Web: Computer Technology, The Internet and National History Day"; (5) "Ideas and Materials: Teaching about Science, Technology, Invention with Historic Places"; (6) "Lesson Plan: Factories and Technology in Industrializing America"; (7) "Lesson Plan: Patents and Invention in American History"; (8) "Lesson Plan: Family History and Flight Technology"; (9) "Essay: The Scientific Revolution in Pre-Modern Europe"; and (10) "Lesson Plan: Medicine, Healing and the Body." The accompanying contest guide, written for students, contains rules that must be followed to compete in any level of the History Day competition. The guide provides an overview, rules for all categories, category rules, and criteria on how entries are evaluated. (BT)

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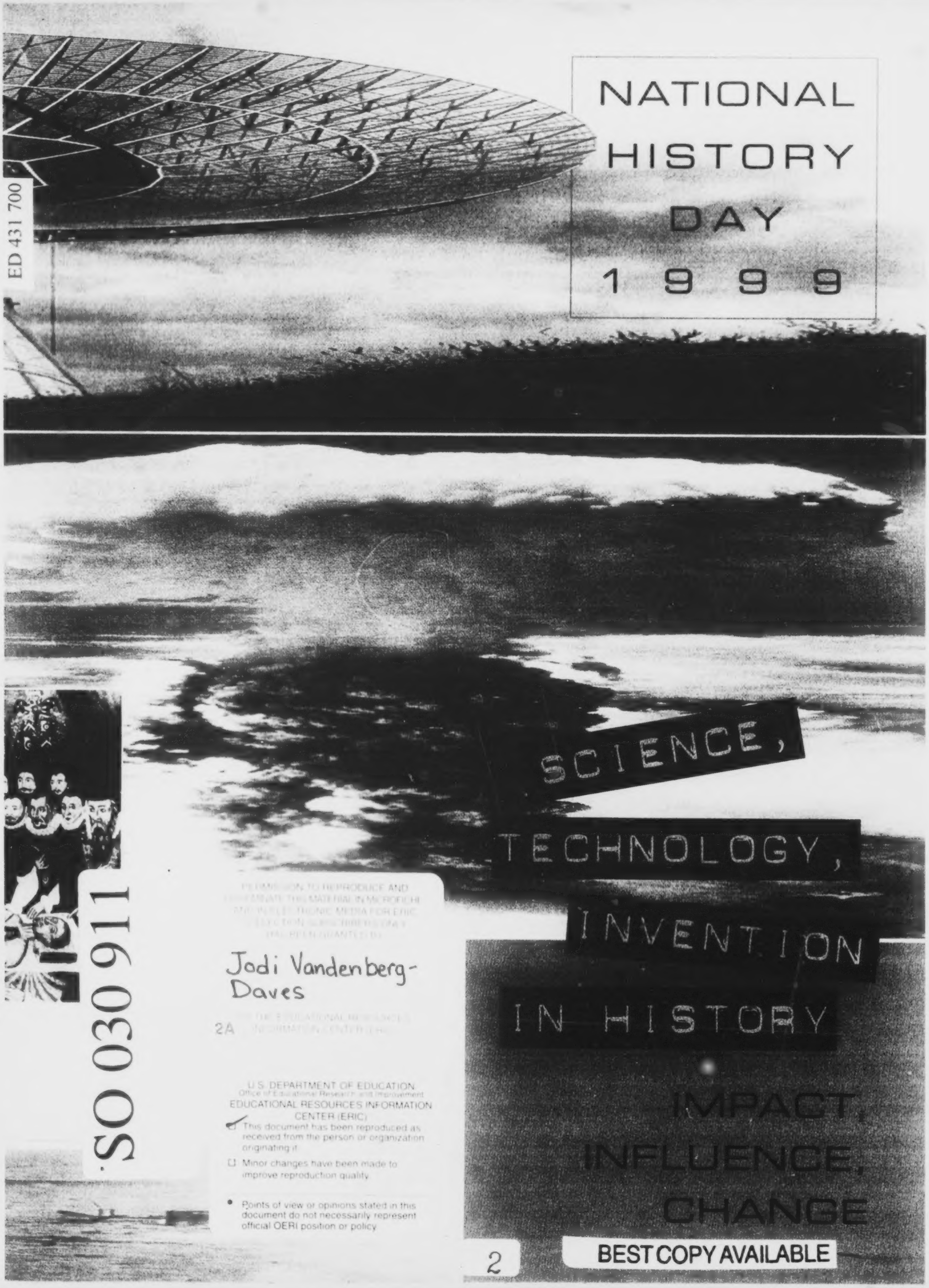

NATIONAL HISTORY DAY 1999

SCIENCE, TECHNOLOGY, INVENTION IN HISTORY

IMPACT, INFLUENCE, CHANGE

SO 030 911

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This teacher guide was made possible by a generous donation from ***The National Historical Society.***

Special Thanks to:

Carroll Pursell, Case Western Reserve University, contributions to bibliography
Fred Gregory, University of Florida/History of Science Society
David R. Smith, Cal State Poly University, Pomona, World History Association (for more information on the World History Association's resources, contact Heidi Roupp, Box 816, Aspen, CO 81612), contributions to bibliography
Jodi Norman, Colonial Williamsburg, contributions to bibliography
Michael Geselowitz, Center for the History of Electrical Engineering, contributions to bibliography and topic suggestions
Robert Friedel, University of Maryland at College Park, editorial assistance
Lisa Berndt, National Museum of Health and Medicine, photo research
Crystal Bailey, State Historical Society of Iowa, photo research
Kirsten Gardner, National History Day intern, contributions to bibliography, compilation of web information, and editorial assistance

Cowles Enthusiast Media, Inc.:

Jennifer McMasters, design and layout
Nan Siegel, Ann Thompson, Allison Torres and Jessica Whitmoyer, editorial assistance
Gina McNeely, photo research

Compilers of Institutional Resource Information:

Kirsten Gardner, web sites
Lee Ann Potter, National Archives and Records Administration
Judy Graves, Library of Congress
Roger Lannius, National Aeronautics and Space Administration
Lynda DeLoach, George Meany Memorial Archives

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Senior Editor, Cathy Gorn, Executive Director, National History Day

Credits: Background images from top: Steerable radio telescope for studying radiation of the sun and moon, 1958 (National Archives and Records Administration); The A-bomb exploding over Nagasaki, 1945 (U.S. Navy Historical Center); The world's first powered, controlled and sustained flight with Orville Wright at the controls, December 17, 1903 (Library of Congress). Insets from top: World War I soldiers receiving typhoid vaccinations (Otis Historical Archives, National Museum of Health and Medicine, Armed Forces Institute of Pathology); riveter at Lockheed Aircraft Corporation, Burbank, California, during World War II (National Archives and Records Administration); Edison's first motion picture camera, built in 1886 (National Archives and Records Administation); Dr. John Banister delivering a lecture on anatomy at the Barber-Surgeons Hall in London, 1591 (National Museum of Health and Medicine).

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TABLE OF CONTENTS

INTRODUCTION:
WHAT IS NATIONAL HISTORY DAY? 4

IDEAS AND MATERIALS:
TEACHING ABOUT SCIENCE, TECHNOLOGY, INVENTION IN HISTORY 6

THEME NARRATIVE, TOPIC IDEAS AND BIBLIOGRAPHY:
SCIENCE, TECHNOLOGY, INVENTION IN HISTORY 8

GETTING CAUGHT UP IN THE WEB:
COMPUTER TECHNOLOGY, THE INTERNET AND NATIONAL HISTORY DAY 16

IDEAS AND MATERIALS:
TEACHING ABOUT SCIENCE, TECHNOLOGY, INVENTION WITH HISTORIC PLACES 24

LESSON PLAN:
FACTORIES AND TECHNOLOGY IN INDUSTRIALIZING AMERICA 26

LESSON PLAN:
PATENTS AND INVENTION IN AMERICAN HISTORY 38

LESSON PLAN:
FAMILY HISTORY AND FLIGHT TECHNOLOGY 42

ESSAY:
THE SCIENTIFIC REVOLUTION IN PRE-MODERN EUROPE 50

LESSON PLAN:
MEDICINE, HEALING AND THE BODY 60

NATIONAL
HISTORY
DAY

PROMOTING THE STUDY OF
HISTORY IN THE SCHOOLS

The theme for National History Day during the 1998-1999 school year is "Science, Technology, Invention in History: Impact, Influence, Change." This teacher guide provides teachers with classroom materials to help students begin to think about the theme, "Science, Technology, Invention in History," to analyze and think critically about a topic's significance in history in relation to the theme, and to continue their analysis through further research. This booklet includes teaching strategies for using History Day in the classroom, lessons on several topics related to the theme, possible topic suggestions for student research, and a selective bibliography of resources.

This booklet is not inclusive. The lessons are to be used to assist students in focusing on a topic and understanding its significance in history through the use of primary sources. Teachers who choose to involve their students in the National History Day program should use the list of suggested topics to help their students begin to brainstorm about other possible topics for study. The bibliography provides sources for students to begin their research. Students who use this material are urged to conduct additional research, since the publication is designed only as a starting point for their work.

National History Day encourages everyone to share this information with students and teachers in their area. This booklet is designed to be used in conjunction with the National History Day Contest Guide. The guide and other related material may be obtained by writing to:

National History Day
0119 Cecil Hall
University of Maryland
College Park, MD 20742

e-mail: hstryday@aol.com
web site:
http://www.thehistorynet.com/NationalHistoryDay

WHAT IS NATIONAL HISTORY DAY?

National History Day is an exciting way for students to study and learn about historical issues, ideas, people and events. This yearlong educational program fosters academic achievement and intellectual growth. In addition to acquiring useful historical knowledge and perspective during the series of district, state and national competitions, students develop critical thinking and problem-solving skills that will help them manage and use information now and in the future.

The program begins in September, at the start of the school year. Curriculum and contest materials are distributed to History Day coordinators and teachers throughout the country. The theme for 1999 is "Science, Technology, Invention in History: Impact, Influence, Change."

In many states and districts, teachers are invited to workshops where they share ideas about how the year's theme can be most effectively addressed and also receive bibliographies and a list of possible topics. Teachers then introduce the program to their students who, in turn, choose a topic and begin their research.

Students are encouraged to choose any topic in local, national or world history and investigate its historical significance and relationship to the theme by conducting extensive primary and secondary research. After analyzing and interpreting their information, students present their findings in papers, exhibits, performances and media presentations that are evaluated by historians and educators.

National History Day has two divisions: the junior division (grades 6–8) and the senior division (grades 9–12). Some states also sponsor a History Day contest for students in grades 4 and 5. Students can enter one of the following seven categories: individual paper, individual or group exhibit (similar to a museum exhibit), individual or group performance (a dramatic portrayal of the topic), individual or group media (a documentary using either slides, video or a noninteractive computer program). Groups can consist of two to five students.

District History Day contests are usually held in February or March. District winners then prepare for and compete at the state contests, usually held in late April or early May. The top two finishers in each category at the state contest become eligible to advance to the national contest held in June at the University of Maryland at College Park.

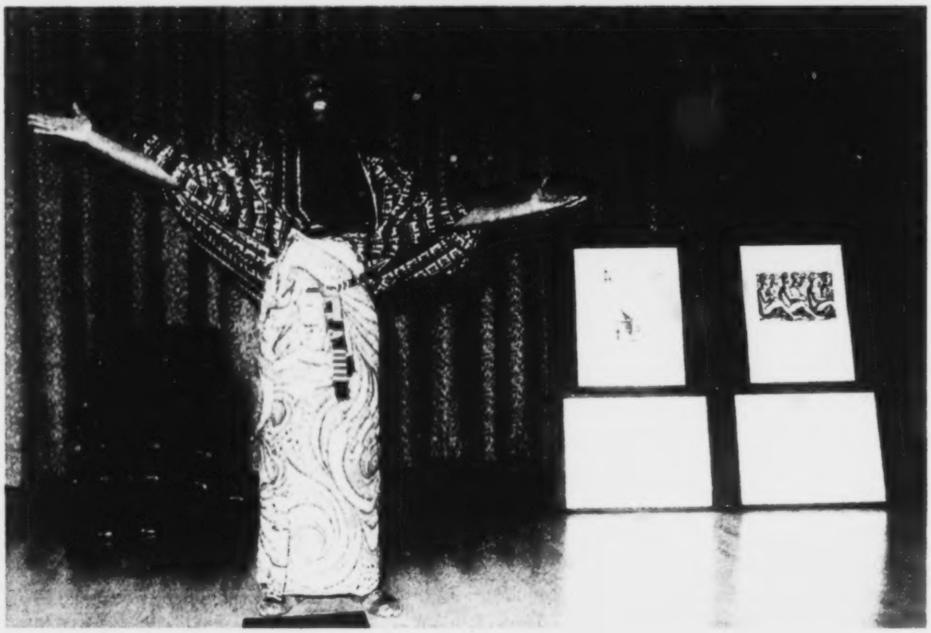
BENEFITS FOR STUDENTS

All types of students participate in National History Day—urban and suburban students; public, private, parochial and home school students; bright students and intellectually challenged students.

Students grow academically and intellectually as they integrate the arts, economics, sciences and other disciplines into a historical presentation. Researching for an entry enhances reading, comprehension, critical thinking and problem-solving skills while fostering pride in each student's heritage and in our nation's history and place in the world.

Preparing for the competitions heightens written, visual and performance presentation skills. The varied formats foster creativity and imagination in presentations.

By participating in the contests, students develop a more positive attitude about their potential as learners and as persons. They



acquire confidence and interpersonal skills that are an important part of the maturing process. Students say they have learned skills that will stay with them for a lifetime.

BENEFITS FOR TEACHERS

National History Day promotes continuing education for secondary school teachers. Teacher workshops promote the exchange of ideas in learning and teaching, building bridges between high school and college educators. Summer institutes for teachers and media specialists closely examine global and multicultural aspects of an annual theme. Curricular aids such as lesson plans and bibliographic guides are provided to all teachers participating in the contest.

As one teacher said on a recent survey, "National History Day encourages creativity in teaching with an emphasis on critical thinking and problem solving—a great improvement over traditional teaching methods, making teaching a more creative, intellectual exercise. The program also provides teachers public recognition that is rarely extended to them in their professional lives."

NATIONAL HISTORY DAY OBJECTIVES

- To provide history teachers with an innovative teaching tool.
- To assist teachers and schools in meeting educational standards that require outcome-based learning activities.
- To encourage the study of history by guiding students to express themselves creatively through presentations of historical topics and materials in a variety of formats.
- To interest students in learning about history by integrating the materials and methods of social studies, art, literature, language and music into their entries.
- To develop research and reading skills and to refine presentation skills in writing, visual projects and performances.
- To develop critical thinking and problem-solving skills that will help students manage and use information effectively now and in the future.
- To encourage students to develop a sense of history as a process and change, a multifaceted development over time that affects every aspect of human life and society.
- To get students out of the school building and into the community, investigating local history.
- To involve parents and other members of the community in students' education.
- To expose students to new and exciting educational environments by holding contests on college campuses and at historical societies.

TEACHING ABOUT SCIENCE, TECHNOLOGY, INVENTION IN HISTORY

In recognition of the increasingly technical and scientific nature of our society, National History Day has designated the 1999 theme "Science, Technology, Invention in History: Impact, Influence, Change." The goal is to help students gain an understanding of the historical, economic, and social ramifications of science, medicine, engineering, computers, technology, and related subjects—to bridge the gap between history and the sciences.

The 20th century has been defined by its technology. Transportation and mobility have changed dramatically with the automobile, the airplane, and even the spaceship. A communications revolution has taken place with the telephone, radio, television, fax, and Internet. And the home, school, and workplace have been transformed by inventions and technological developments that have changed Americans' daily lives, from the toaster to the powered lawnmower to the digital computer. As the pace of these and other scientific and technological changes accelerates, the challenge of creating an educated citizenry grows. It is therefore important that students develop an understanding of the impact of the science and technology that helped shape the past and which will continue to play a crucial role in the future.

Young people need to understand that although technology depends upon math and science, it responds to and is shaped by human values—values that vary from time to time and place to place. Only by examining the historical roots and interactions of science and technology will students begin to understand the nature and significance of our scientific and technological society. With such a foundation, young Americans will be better prepared to enter the 21st century with the knowledge to evaluate both social and scientific policies, and to make informed decisions regarding the ever increasing role of science and technology in society. To that end, National History Day encourages teachers to incorporate this subject into their annual classroom curricula.

Textbooks are generally quite deficient in dealing with this subject matter. Such sources generally explain the impact of the larger historical developments related to technology, such as the Industrial Revolution or the general impact of inventions like the electric light or steam engine. But textbooks fall short in examining in depth the broad and significant impact of the development of science and technology and their impact on the daily lives of individuals. Thus, to complement and enhance textbook material, to encourage teachers to help their students delve more deeply into this complex subject, and to assist educators in incorporating the history of science and technology into their existing classroom curriculum, National History Day offers this book as an introduction and guide.

The materials provided in this teacher guide are examples of strategies and resources that can be used to initiate or enhance existing lessons and units taught in history and social studies classes. All the material can be adapted or modified by the teacher. The lessons are designed to encourage students to think critically about various topics and to conduct research, to interpret primary sources, and to explore the larger significance in history of topics that interest them.

This guide offers both lessons on specific topics and a range of resource ideas, from bibliography, to online information, to historic sites. The beginning section of this booklet, "Getting Caught Up in the Web," offers guidance to teachers and students on appropriate uses of the Internet for historical research and National History Day. A growing number of students are finding information for their History Day projects online. But despite the possibilities for historical research provided by the Internet, there is caused some confusion regarding its proper use and the value of the material available. Thus, the section in this book provides guidelines that help students ask and answer important questions about the use of the Internet in conducting historical research. The opening section of "Getting Caught in the Web" defines the Documentary Category (formerly Media Presentations) and helps students understand the proper use of computer technology in producing History Day entries. In "Evaluating Internet Research Sources," teachers and students will find some suggestions for evaluating the quality and credibility of information found on the Web. A compilation of Web sites provides some online resources where students might search for topics related to science, technology, invention in history.

This booklet also contains numerous resources from organizations and government agencies that have a wealth of information related to the history of science, technology, invention. The article "Teaching About Science, Technology, Invention with Historic Places" offers guidance to teachers on how historic sites can be useful for instruction and lets students and teachers know how to find sites in their area that range from scientific testing facilities, to the homes of famous scientists, to industrial sites. In addition,

Sixth grade students and teacher holding books on atomic energy from their science class, 1958 (courtesy State Historical Society of Iowa, Des Moines).

the National Archives and Records Administration, the Library of Congress, the National Aeronautics and Space Administration, and the George Meany Memorial Archives have compiled information related to the theme from their vast resources. Many of those resources are now available online.

The first two lessons look broadly at aspects of technology and invention in U.S. history. In "Factories and Technology in Industrializing America," students learn by reading personal accounts of how workers experienced the introduction of new machines in factories. They also explore the beginnings of modern "scientific" management practices through primary source interpretation and by simulating scientific management techniques in class. In "Patents and Invention in History," students learn about the role of the U.S. federal government in protecting the rights of inventors and discuss the role of invention in American history and society. Both of these lessons help students look at the personal significance of larger technological developments and inventions.

In the lesson "Family History and Flight Technology," students learn about the intersection of one person's life history with larger historical events. In addition, teachers are offered useful activities for involving students in questions about how the lives of their family members were shaped by some of the scientific and technological changes that have marked the twentieth century. The lesson also serves as an excellent introduction to using historical artifacts to teach history and engage students in discovering the past.

Scientific and technological developments are not the prerogative of the 20th century nor the Western world. Long before the advances of modern science and long before the invention of mechanically powered technology, individuals all over the globe experimented with and developed both scientific and technological innovations that laid the foundations for future developments. The essay on "The Scientific Revolution in Pre-modern Europe" provides background for teachers and students who are high-school-level readers on how scientists of the Renaissance created systems of thought that shaped much of the modern world. The lesson "Medicine, Healing and the Body" offers students a glimpse at medical practices in the ancient cultures of China, India, and Greece, by looking at excerpts of classical medical texts. Students are asked to consider how we might think about "science" before the scientific revolution and outside the context of Western cultures.

All of these lessons are designed to encourage students to come up with additional ideas about science, technology, invention in a variety of time periods and places. The topic suggestions and selected bibliography provided in this book are simply a starting place for students and teachers interested in this broad theme. Students who want to research topics for participation in National History Day should develop additional ideas. They may start their research by examining some of the sources listed, but should continue their investigation for more resources at libraries, archives, museums, historical societies, and other places around their communities to discover the significance of the interaction in everyday life of science, technology, invention in history.

SCIENCE, TECHNOLOGY, INVENTION IN HISTORY

During the 1998-99 school year, National History Day invites students to research topics related to the theme "Science, Technology, Invention in History: Impact, Influence, Change." The theme is broad enough in scope to encourage investigation of topics ranging from local to world history. To understand the historical importance of their topics, students must ask questions of time and place, cause and effect, change over time, and impact and significance. They must ask not only when events happened but also why they happened. What factors contributed to their development? Regardless of the topics chosen, students must not only present a description of their chosen topic but also draw conclusions about how their topic had an impact on the course of events, individuals, communities, nations, or the world.

Late 20th-century Americans face profound questions about the role of science and technology in society, questions that we sometimes think are brand new. Of course the Mayans never had to create policies about cloning or regulate the uses of the Internet. Nor could eighth-century Europeans conceive of sending a person to the moon. But throughout human history, the introduction of new technologies and the evolution of scientific knowledge have had significant social, cultural, and economic impact on societies. The theme is designed to engage students in questions about *why* scientific and technological developments emerged when they did and what *impact* they had, not only on the progress of science or technology, but on individuals and societies.

Students investigating this year's theme will discover the influence of the spirit of a particular era in a particular place on what was discovered, who made the discoveries (and who got credit for them), and whether or not those discoveries had a lasting impact. One of the most significant examples is the European Renaissance, which occurred after centuries of European neglect of scientific investigation. Out of this Renaissance came innovations that would forever change the world, such as the printing press, the clock, and modern maps of the earth, as well as revolutionary knowledge of astronomy, biology, the human body, mathematics, botany, and the earth's geography. Students might create an exhibit that examines a key innovation of the European Renaissance, such as the development of new knowledge of human anatomy, and explain the significance of this new knowledge.

Students might investigate major debates in history over scientific theories that challenged cultural and religious values as much of Renaissance science did. Students might create a performance on the trial of Galileo or the Scopes trial in the United States, in which a Tennessee high school teacher was convicted of breaking a state law by teaching about evolution instead of the Biblical creation story. A group of students might write a performance in which they play the roles of Ptolemy and Copernicus and a contemporary astro-physicist debating their theories and evaluating their roles in history as people who challenged the values of their day with new scientific ideas.

Why were some inventions and theories developed and widely accepted at certain moments in history? What motivated inventors to develop new tools, machines, and products? Students interested in cars might consider the conditions that led to the invention of the automobile, or the conditions that permitted its large-scale production. This technology had an enormous impact on people's ability to travel and eventually influenced where people lived and how they spent their leisure time. (The modern custom of "dating," for example, was born with the automobile!) As with many other inventions, governments played a role in facilitating the use of this new technology—in this case by building roads, setting speed limits, and licensing drivers.

What factors influence a society to invest in the promotion of a particular invention, or devote resources to scientific research? Why did states set up geological surveys in the 1830s? Why did the U.S. government fund the research that would create the atomic bomb, one of the most dramatic developments in all of military history? A student might write a paper that explores the reasons for government funding of research on new technologies after World War II, such as plastics, which would help usher in the age of mass consumption. Students might develop a video documentary on the history of the National Aeronautics and Space Administration (NASA) using President John F. Kennedy's speeches about space exploration.

Students might also examine topics that illustrate the ebb and flow of a particular culture's interest in sciences or technologies. Japan was once the world's leader in armament technology, but the lessening of the need for warfare in the seventeenth century led that society to reduce its interest in weapons and military technology. Similarly, the legacy of ancient Greek science was all but forgotten during the European "dark ages"; meanwhile, Arab scientists studied and improved upon the innovations and scientific theories of the ancient Greeks. China's technological superiority to Europe in areas ranging from nautical technology to immunology lasted for centuries, but it was Europeans who ushered in the "scientific revolution." How might some of these developments be explained? What impact did they have?

Students might be interested in technological innovations that never caught on, or technologies that were not developed to capacity. A student could look at materials from the U.S. patent office and write a paper on products that received patents but were never used. Students interested in recent world history might examine the role of agencies such as the World Bank in introducing new technologies in the Third World. What factors helped or hindered the adoption of a new technology introduced by another culture? How did new technologies fit—or not fit—people's economic circumstances, work patterns, or geography?

What costs—social, cultural, and environmental, as well as economic—accompanied new technologies? Why did people sometimes continue to use old tools rather than adopt new ones? What did it cost to promote and popularize an invention? One example of a successful promoter/inventor was American engineer Willis Carrier, who invented an air conditioner in 1902. He managed to popularize it some 20 years later by improving its efficiency and selling it to movie theaters, and from that point on, the air conditioner would have wide-ranging impact on American society. Other inventors lacked economic resources to promote their ideas, and were outcompeted by comparable inventions before they ever managed to get people's attention. Still others developed inventions whose value would not be recognized for years after their deaths.

Very close to home, students can find examples of how people developed, responded to, and made choices about new technologies. For example, as the industrial revolution emerged in the United States, many people praised America's progress, while others worried about the impact of the machine on social life. A host of new technologies developed in the nineteenth century took the production of basic materials, from shoes to butter, out of the artisan's home-based shop and the housewife's kitchen and into factories. How were people influenced by new machines in the home, such as the spinning jenny, or new machines in the workplace, such as the conveyor belt? Students might develop a performance which dramatizes the impact of new technologies on the rise of the U.S. labor movement. Students from rural backgrounds might interview their grandmothers about the introduction of the tractor to farms in the 1930s. This invention reportedly reduced women's need to continue cooking for large groups of workers and therefore had a broad impact on their work and leisure. What other ripple effects of technology can be found in family or community history?

Students might also ask how certain machines and technical tasks became associated with one sex or another, or with a particular racial or ethnic group. Did the introduction of new machines into a workplace reinforce the subordinate position of some groups of workers, or were there some cases when groups with less power in society gained stature by mastering a new technology? A student might examine the movement of women into the operation of heavy machinery during World War II. Women workers were told that cutting out steel airplane parts was much like cutting out dress patterns! Students might investigate their own communities, and ask, which machines are used by whom? How and when did people start using the machines that one sees in the day-to-day life of one's community? How did these machines change their lives and their community?

Students might be interested in how a particular geographic environment influenced the development of new inventions and technologies. How did people's need to cross terrain, find new trade routes, or navigate oceans and rivers influence the course of technological development? How did civilizations in ancient China or medieval West Africa develop ways to communicate with their far-flung populations? Students might create an exhibit on the Chinese invention of the rudder, a key piece of nautical technology, in the first century AD. It was adopted in the West around twelfth century, and this invention made possible all subsequent European voyages, including that of Christopher Columbus.

What role did natural resources play in a particular culture's inventions? For example, some Native American Indians used the inner bark and leaves of willow trees to extract a pain-relieving chemical called salicylic acid, the active ingredient in modern aspirin; they used the willow's pliable branches to fashion arrows. On the other side of the globe, Africans were using the medicinal properties of the cola nut to relieve nausea and heal wounds, while taking the cola nut trees' bark to build their houses and boats. Tens of thousands of years earlier, Africans near the Nile had adapted to and changed their natural environment when they became the world's first scientific cultivators of food crops.

And why did people develop different technologies to adapt to the same environment? For example, 17th-century colonists in New England approached the land quite differently from the Native American Indians. The colonists found Native Americans burning over segments of land and then letting the land lie fallow for decades, moving to new areas to grow food, thus altering the environment but not wearing out the soil. The colonists brought with them a more settled approach to the land. They imported livestock animals, which packed down the soil, and they built fences and cultivated crops in the same soils year after year, eventually developing a need for fertilizers that Native American practices did not require. Students interested in how cultures adapt to an environment might develop an exhibit on the use of Old World farm implements in the New World, looking at Scandinavian tools in the Upper Midwest, for example. Or students might create a documentary that examines some of the many different ways people have cultivated and harvested rice, a crop grown in many parts of the globe.

Students might also examine how and why certain practices and ideas came to be called "scientific." Why were some "scientific" approaches to illness totally ineffective? Students might develop a performance that dramatizes the impact of the now discredited nineteenth-century "science" of phrenology: the study of the shape of the skull. Practitioners of phrenology argued that the shape of the skull of European-Americans indicated their mental superiority. Students might also ask how the term "social science" evolved. Students might research some of the world's earliest social science questionnaires, which were used in various pre-modern societies to take a census, usually for tax collection purposes. Or students might create a performance on the history of home economics in the early 20th century, asking why proponents of home economics wanted to make their advice to homemakers "scientific," introducing precise measurements to baking, for example.

As students explore science, technology, and invention in history, they will certainly be struck by both the enormous opportunities afforded by these developments and the often unexpected costs of scientific and technical "progress." Students might examine human reactions to promising technologies that went awry, such as nuclear power in the Three Mile Island or Chernobyl accidents, the drug Thalidomide, or industrial accidents caused by machinery at work. Science fiction is one way that people have recently approached their fears about technology slipping out of human control. An interesting paper might be developed on science fiction writing about the computer in the latter half of the 20th century.

The theme "Science, Technology, Invention in History" opens up vast areas of inquiry for students and offers them new analytical tools to think about the ethical, political, and social challenges and opportunities created by scientific and technological developments. The theme is a broad one, so topics should be selected and developed in ways that best use students' talents and abilities. Whether a topic is a well-known event of world history or focuses on a little-known individual from a small community, students should be careful to place their topics in historical perspective, determine the significance of their topics in history, and show development over time.

Students should also provide an analysis of the materials used and give a clear explanation of the relationship of the topic to the theme "Science, Technology, Invention in History." Then, students may develop papers, performances, documentaries and exhibits for entry into National History Day competitions.

TOPIC IDEAS

Note: The following is a list of possible topics for investigation and interpretation for National History Day 1999. The list is not inclusive; rather, it provides a starting point for teachers and students to begin brainstorming to come up with ideas for National History Day entries. The list includes both narrow topics and broad themes, which students will need to narrow in order to develop manageable research projects for National History Day entries. Students should keep in mind that many excellent research topics can be found by investigating local history in their area.

- Germ theory and its consequences for public health
- Developments in surgery during the Civil War
- Acceptance of Copernicus' theories
- Scientists who made discoveries about local geology, animals, and plants in your area
- Science research facilities in your area: how and why they were established; what impact they had
- Development of agricultural science in the Midwest
- 20th-century wars and scientific discovery: from penicillin to the atomic bomb
- 19th-century medical views of women
- Development of the conservation movement in the 20th century
- Genetic research and theories about criminal behavior: social and legal implications
- Women in science: their methodologies, questions, and approaches
- Eugenics: the social application of Darwin's theory?
- Can we call it science? Ineffective medical practices of the 19th century
- Key innovations in cartography (map making) and their impact
- The printing press: the world's first Information Revolution?
- Mechanization of agriculture and African-American migration
- The "Green Revolution": science and technology in agriculture
- Taylorism: impact of the science of management on workers
- Key question of the industrial revolution: the English began it, but the Americans surpassed them
- History of the role of a technology in the life of your community
- The role of technology in the shift from family farm to agribusiness
- Medical technologies used in childbirth in colonial and 19th-century America
- The wheelbarrow: the impact of an ancient Chinese invention on industry, military and agriculture
- The stirrup: an ancient Chinese invention makes possible feudal battles in Europe
- The role of mining technology in the economy of the American West
- The coming of the railroad to the American West: key consequences of a new technology
- The 1893 Chicago World's Fair: new technology on display
- The Chernobyl nuclear accident and its social, environmental, and economic impact
- Mediterranean trade routes and exchange of technology: Africa, Europe, and the Middle East
- Development of the recording industry and impact on African-American blues singers
- The Tennessee Valley Authority: bringing new technology to rural areas
- The consumer protection movement and its impact on the development of new technologies
- "R&D" (research and development) in the recent past: government and corporate policies to foster invention
- "Rosie the Riveter": women and industrial technology during World War II
- Rachel Carson: scientist, author, and catalyst to a movement
- Elijah McCoy (the "real McCoy"): the story of an African-American inventor
- Indoor plumbing and its impact on women's work
- NASA: why it developed and its impact on American society
- Henry Ford's Model T: "a car for the multitude"
- Building technologies of the Incas: roads, irrigation, masonry
- Development of a patenting office in the U.S. government
- Leonardo da Vinci's inventions
- Benjamin Franklin's most significant inventions
- The transistor: beginnings of "miniature" technology
- The plastics revolution
- Oliver Evans' automated flour mill: laying the groundwork for factory automation
- Military innovations with civilian uses: the autopilot, medevac

helicopters, the locator beacon
- The Rust brothers and the mechanical cotton picker: a tale of independent inventors
- Technology and 20th-century change in war: the tank, poison gas, the machine gun
- The antibiotic revolution in medicine
- History of the U.S. Fish and Wildlife Service: science, economy, and ecosystems
- Air conditioning and its impact on Southern society
- The invention of the movies and the impact on Americans' leisure time
- Technology and the labor force: the rise of "technicians" and technical training
- The discovery of acid rain
- Napalm: military technology affects a debate over the Vietnam War
- The Tuskegee syphilis experiment: science, race, and ethics in the early 20th century
- Insulin treatment of schizophrenia and other mid-century treatments of mental illness
- Transportation revolution: the interstate highway system and its impact
- Technology, toys, gender: the toy industry's impact on how girls and boys learned technology
- The impact of scientists' discoveries about geologic time
- The rubber industry and its impact on Latin America
- The stethoscope, thermometer and other measurement tools: their impact on the practice of medicine
- Inventors who never got credit for their work
- Politics and technology in your community: building a local dam, shutting down a reactor, factory pollution, and health problems
- The barbed wire fence: its role in the economy and culture of the American West
- The role of technology in the clash of cultures: Spanish conquest of the Incas, the West and Japan during the Meiji period, or classical Romans and European "barbarians"
- Metallurgy in ancient East Africa
- Arabic numerals and their introduction to Europe
- Evidence of a culture's knowledge of math: architectural design, games, trade activities
- Great Zimbabwe: a 12th-century architectural site and its revelations about engineering knowledge
- Maritime technology and its influence on trade networks
- Interchangeable parts and their impact on industry
- The balloon-frame house: the impact of standardization on American homes
- From hunter-gatherers to crop cultivators: the impact of the science of crop cultivation

A sampling of 20th-century inventions with wide-ranging impact:

- electric washing machine
- telephone answering machine
- computer chip
- electric lighting in the American home and office
- traffic light
- fax machine
- television
- lie detector
- refrigerator
- airplane
- radio

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COMPUTER TECHNOLOGY, THE INTERNET AND NATIONAL HISTORY DAY

by Cathy Gorn, National History Day

Computer technology is revolutionizing National History Day (NHD) entries from beginning to end. Although students have almost always used computers to enhance and produce entries in the paper, exhibit and multimedia categories, computer use has proliferated in the last few years. More and more students are choosing to develop entries with computers, use them as presentation vehicles, and conduct historical research by exploring the Internet for primary and secondary sources. Online network technology has opened up great possibilities for students to gain access to previously inaccessible resource material and provides a new avenue for creatively presenting information on the World Wide Web. Yet it also has been the source of confusion for NHD students who have struggled to use this new technology effectively. How can students make the most of computer technology in developing NHD entries? The following provides some guidelines.

THE COMPUTER: PRESENTATION VEHICLE OR A TOOL FOR DEVELOPING PRESENTATIONS?

Computers have for years been an excellent tool to help students create and produce NHD entries. A stroll through the exhibit room or a review of papers or documentaries at any NHD contest reveals a wide array of uses for the computer. Most students use computers to write papers, topic descriptions and bibliographies. Many have proven that they are adept at using computers to create illustrative maps, graphs, timelines, charts and exciting graphics for their entries. For example, at the 1997 national contest, one student's exhibit displayed a computer-generated pie graph that detailed the outcome of "Human Tragedies of the Texas City Disaster" and a chart that showed a subsequent "Triumphant Rise of Population in Texas City." Another exhibit included a graph that compared black and white populations in a Florida community between 1880 and 1920. Graphs and charts like these strengthen the analysis of an NHD entry and allow students to include significant information while adding to the entry's overall visual appeal. Some students even include small computers within their exhibits that display graphic presentations or short video clips. At every contest, students display their creativity in the Documentary category by using computer technology to create special effects in the form of animation, graphics and other visuals for slidetape and videotape presentations. These examples indicate that students not only understand computer technology and know how to use it effectively to visually enhance their entries, but they also reveal that students are using computers to help them analyze and interpret information about their topics.

However, despite students' increasingly sophisticated and creative use of technology, there remains some confusion regarding the most effective use of computers in the Documentary category. Rather than use computers as tools to help them create aspects of their presentations, some students have tried to use computers as vehicles for presentation, most recently in the form of web pages as NHD entries. Although web pages are a great source of information and fun to create, they are not a particularly effective vehicle for making interactive historical presentations, and they present a problem for NHD judging.

THE HISTORY DAY ENTRY AS PRESENTATION: THE DOCUMENTARY VS. THE WEB PAGE

NHD recently changed the name of one of its categories from Media Presentations to Documentaries to reinforce the principle that students' History Day entries should be interpretive presentations. Student documentaries should resemble (in shorter versions) the kind of documentaries that appear on PBS stations or The History Channel. The goal is to provide students with an opportunity to make an interpretive audiovisual presentation about a historical topic and its significance in history.

Since the introduction of the Internet, some students participating in NHD have expressed an interest in creating web pages as History Day entries. But rarely is a web site an interpretive presentation. Instead, a web site is usually an area where one can investigate a topic and gather information. Like shoppers in a department store, viewers of web pages explore information, stopping to look at what interests them, passing by pages that are of less interest, and spending as much or as little time in each area as they like. Web pages often provide viewers with good information and general impressions about a topic but rarely with an understanding of the creator's analysis of the topic's historical significance. Genuine analysis cannot be effectively presented by allowing an individual to jump from place to place.

Documentaries can accomplish that task much more effectively. A documentary presents information that advances an interpretation—a central argument that the producer or producers want to make. The producer controls the order, sequence and overall or-

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ganization and flow of information to effectively present an interpretation of a topic that draws conclusions about a topic's significance in history.

The History Channel programs and its web site serve as an example. A visit to The History Channel's web site (http://www.historychannel.com) reveals program schedules and other information about The History Channel and its programs and features; there, one can gather information about the cable network and the various programs that it offers viewers through the cable television network system. But viewers will not find any documentaries—interpretive historical presentations—on the site. Instead, the historical documentaries that The History Channel produces can be enjoyed on television. In the same way, NHD judges should be able to enjoy student documentaries through multimedia (often slidetape or videotape) presentations without having to interact with the presentation by working a mouse or clicking on a site. If History Day students focus on creating interpretive documentaries instead of interactive pages of information, they will meet the goals and challenges of NHD: to create effective, analytical, concise presentations based on careful historical research.

SOURCE SURFING ON THE NET: CONDUCTING HISTORICAL RESEARCH ONLINE

The research process has been enormously enhanced by growing student access to the Internet, which has opened up a new world of resources. This has been a gold mine, especially for those students in rural or remote areas where access to major research libraries and archives is limited or nonexistent. "Surfing the Net," students can access university libraries, state and national archives and other types of repositories and discover a wide range of materials from the many and varied web sites accessible by the click of a mouse, and they can even tour historic sites online. The web, with its use of color, sound, graphics and animation, has turned on many members of the MTV generation and made the history experience exciting to young people. But although the Internet has brought exciting new material into students' homes and the classroom and provided access to hitherto inaccessible resources, it has also brought confusion regarding research methodology and the credibility of resources.

"Why leave home to do research when I can just cruise the Net?"

The excitement and accessibility of the Internet has caused many History Day students to get "caught in the Net" and as a result fail to conduct a balanced research effort. Some students have become so enamored with the quantity of information available at the click of a mouse that they have falsely assumed that the Internet can provide one-stop shopping for all of their research needs. But the Net is only one source of information and should be used as only one part of a well-rounded program of research that includes libraries, museums, archives and oral history interviews.

Before students explore the web or the library, teachers and media specialists should prepare students for the research process. Students need instruction about research techniques, background reading, primary sources and the wide variety of repositories that might be consulted. And throughout the research process, teachers should work closely with students to monitor their progress and provide guidance and advice.

After choosing a topic, students should begin the research process by reading background information, including books and journal articles, on their chosen topics. Conducting an initial foray on the Internet, students may find short, encyclopedic-type essays or brief descriptions about their topics. But for most topics, students will not find sufficient secondary material on the web. Reading a short essay or summary online is not enough. Students should read secondary sources related to their topics and find out how different historians have examined the same topic or related topics. The first place to begin is at the school library or public or university library in the student's hometown. Students who live in rural or remote areas can turn to the Internet to access public and university libraries online and obtain books and journals through interlibrary loan. Once students understand the topic generally and the overall context in which the topic fits, then they should turn their attention to finding other sources, especially primary sources, to help them interpret and understand their topic further. One place to search for material is the Internet, but it will not include all sources available or useful. Background reading will help students devise questions that will lead them to primary material online and in archives, museums, libraries and other repositories.

"I looked on the Internet and couldn't find anything on my topic."

Many students who get caught in the web are under the misguided impression that they will find all the sources—including primary sources—that they need on the Net; if it isn't there, many assume it never existed to begin with. But the fact remains that the Internet, as vast as it is, contains only a very small percentage of the research materials and documents in existence.

Many repositories are digitizing documents and placing them online. But this is usually only a very small percentage of their holdings and a very select group of materials. While some of these documents may be useful to students conducting research on a particular topic, the sources online may not include all the sources that students should review or the most useful and telling source for a given topic. Web sites for most repositories, including the National Archives and Records Administration, state archives and Library of Congress, include only one to two percent of their actual holdings. For every 10 documents online, there may be hundreds available at the repository itself. The materials on the Internet have been selected as representative documents of the entire collection and are often the most asked for or most popular examples. Thus, some of the most pertinent information for many topics cannot be found online. A student conducting research for a History Day entry—or any historian engaged in research activities—should not be satisfied seeing only a small percentage of what is available, especially since it is selected by someone else and not the researcher.

In addition, for many topics it is nearly impossible to find good, credible primary sources on the Internet. Some of the most interesting NHD topics are often local in nature, and much of the source material related to such topics is not available online. This does not mean that the material does not exist. Rather, such material can often be found easily at local and state archives and historical societies. But to find them, students must leave their computers and write to or visit such repositories.

NHD judges are very much aware of these issues. When they evaluate student entries, they will be skeptical if student bibliographies reflect only Internet resources. Student bibliographies will be evaluated on the breadth and balance of the research. Students will be most successful if they can show that they have consulted a variety of sources. History Day bibliographies that reflect only Internet sources (or only encyclopedias, or only secondary sources, etc.) will send a message that the students have not searched widely for sources and have, in fact, taken the easy way out of their research.

USEFUL WEB SITES RELATED TO THE HISTORY OF

Note: This is not an exhaustive list, but these sites do provide some useful starting points for students searching for topics and information.

National History Day
http://www.thehistorynet.com/NationalHistoryDay
Sponsors: National Historical Society; National History Day
Utility: Provides program information on National History Day; explains the theme (ideas on how to teach it, competition guide); links to useful sites; provides updates on this year's theme

American Association for the History of Medicine
http://www.auhs.edu/aahm
Sponsor: American Association for the History of Medicine
Subject Matter: History of medicine
Utility: Lists the names and phone numbers of all of their members in the United States by state
Documentation: Links to many medical history sites

American Institute of Physics
http://www.aip.org
Sponsor: American Institute of Physics
Subject Matter: Physics (with a history of physics section)
Utility: Has some online exhibits
Documentation: Photographs; scholarly articles; biographies

Chemical Heritage Foundation
http://www.chemheritage.org
Sponsor: Chemical Heritage Foundation
Subject Matter: History and heritage of chemical engineering and its scientists
Utility: Gives biographies of chemical engineers; links to sites of science-related libraries with online scholarly articles
Documentation: Photographs; biographies; scholarly articles

Colonial Williamsburg
http://www.history.org
Sponsor: Colonial Williamsburg
Subject Matter: Colonial Williamsburg
Utility: Has a search engine for online historical resources about the 1700s (under "Search This Site")
Documentation: Paintings; primary and secondary documentation; biographies

The East Asian History of Science Library
http://www.soas.ac.uk/needham/library
Sponsor: Needham Research Institute
Subject Matter: History of East Asian science
Utility: Access to their library of East Asian science history; access to the work of Joseph Needham; allows teleneting to their online documents
Documentation: Full texts in English online

Exploratorium ExploraNet
http://www.exploratorium.edu
Sponsors: The state of California, California Department of Education
Subject Matter: Science
Utility: Gives history on some of their exhibits (e.g., Solar Eclipse)
Documentation: Photographs; scholarly journal excerpts; personal accounts

The Faces of Science: African Americans in the Sciences
http://www.lib.lsu.edu/lib/chem/display/faces.html
Sponsor: Louisiana State University
Subject Matter: African Americans in the sciences
Utility: Lists African Americans with doctoral degrees in science
Documentation: Photographs; biographies; charts; graphs

Henry Ford Museum & Greenfield Village
http://www.hfmgv.org
Sponsor: Henry Ford Museum & Greenfield Village
Subject Matter: Henry Ford Museum & Greenfield Village
Utility: Histories of innovations and innovators online
Documentation: Photographs; pictures; biographies

The History of Mathematics
http://www.maths.tcd.ie/pub/HistMath
Sponsor: Trinity College, Dublin
Utility: Gives biographies of mathematicians
Documents: Photographs; biographies; links to further online documents on the history of mathematics

Horus Gets in Gear: A Beginner's Guide to Research in the History of Science
http://www.kaiwan.com/~lucknow/horus/guide/tp1.html
Sponsor: University of California, Riverside, Department of History
Subject Matter: History of science
Utility: Links to history of science sites; search engine for history of science

IBM Patent Server
http://www.patents.ibm.com/ibm.html
Sponsor: IBM
Subject Matter: Patent search
Utility: Allows patent searches by invention; reproductions of actual patents from January 5, 1974, to present; links to other web patent searches; bibliographical information on the patents
Documentation: Patents online

IEEE History Center
http://www.ieee.com/history_center
Sponsor: The State University of New Jersey, Rutgers; IEEE (Institute of Electrical and Electronics Engineers)
Subject Matter: History of electrical engineering
Utility: Online documents on the history of electrical engineering
Documentation: Scholarly articles (including origins of IEEE, a century of electronics, lines and waves, this month in electrical history, a list of milestones in electrical history); oral histories; links to 25 different sites dealing with history of science

Index of Resources for Historians
http://history.cc.ukans.edu/history/index.html
Sponsor: University of Kansas
Subject Matter: Virtual History Library
Utility: Links to 40 different sites dealing with science, technology and medicine

EVALUATING INTERNET SOURCES

Students may also get caught in the web and do their NHD entries more harm than good by accepting the legitimacy of sources without verifying their credibility first. There is an awful lot of stuff floating around in cyberspace, but not all of it is legitimate, credible or useful as source material for historical research. Teachers and school media specialists should instruct students to evaluate their resources, both in print and online, by asking questions about the source's origin and authorship. The guidelines by Professor Robert Harris on page 20 can help.

SCIENCE, TECHNOLOGY, AND INVENTION

Jerome and Dorothy Lemelson Center
for the Study of Invention and Innovation
http://www.si.edu/lemelson
Sponsor: Jerome & Dorothy Lemelson; National Museum of American History, Lemelson Center
Subject Matter: Inventors, inventions, innovations
Utility: History of some inventions; access to archival information; links to other good sites related to invention and innovation
Documentation: Audio/visual; photographs; biographies; archives on inventors

The Library of Congress
http://www.loc.gov
Sponsor: U.S. government
Subject Matter: Documentation owned by the Library of Congress
Utility: Online catalog to the Library of Congress Online documents
Documentation: Photographs; sound recordings; motion pictures; bibliography; maps; documents *(See "Library of Congress Resources Available Online" on page 22 for more information)*

National Archives and
Records Administration
http://www.nara.gov and
http://www.nara.gov/education/classrm.html
Sponsor: U.S. government
Subject Matter: Primary documents from U.S. government (beginning to present)
Utility: Has a section to help National History Day students get started
Documentation: Photographs; posters; paintings; primary documents *(See "Online Resources from the National Archives and Records Administration" on page 23 for more information)*

National Inventors Hall of Fame—
Inventure Place
http://www.invent.org/book/index.html
Sponsor: National Inventors Hall of Fame, Akron, Ohio; Continental Airlines
Subject Matter: Inventors
Utility: Biographies of inventors; search by inventor or invention; good secondary source of background information
Documentation: Photographs; biographies

National Park Service—History
http://www.nps.gov/crweb1/history/crhist.htm
Sponsor: National Park Service
Subject Matter: National Park Service
Utility: History of the National Park Service; offers access to historians specializing in various aspects of American history, including science and technology, via e-mail under "Ask A Historian"; information on historic sites
Documentation: History of the parks; photographs *(See "Teaching About Science, Technology, Invention with Historic Places" on page 24 for more information)*

Native American Knowledge
Resources on the Internet
http://hanksville.phast.umass.edu/misc/indices/NAknowledge.html
Sponsor: University of Massachusetts
Subject Matter: History of scientific knowledge of Native Americans
Utility: To learn about the Native American knowledge of science and technology
Documentation: Pictures with explanations; scholarly articles

The Nobel Prize Internet Archive
http://nobelprizes.com
Sponsor: Almaz Enterprises, Inc.
Utility: Lists Nobel Prize winners in all categories
Documentation: Biography of each winner; links to further information on winners

Science and Technology
in Western Civilization
http://www.inform.umd.edu/ARHU/Depts/History/Faculty/RFriedel/hist175-f97.html
Sponsor: University of Maryland, Department of History; Professor Robert Friedel
Subject Matter: History of science and technology in the Western culture from ancient times to the present
Utility: Links to primary document sites; links to sites on the history of science and technology; organized by time period

Smithsonian Institution Research
Information System
http://www.siris.si.edu
Sponsor: Smithsonian Institution
Subject Matter: Smithsonian Archives
Utility: Allows a search of Smithsonian documents
Documentation: Library; art inventories; archives and manuscripts; research/bibliographies; Smithsonian chronology

The Society for the History of Technology
http://www.umich.edu/~shotac/SHOT/index.html
Sponsor: Society for the History of Technology
Subject Matter: History of technology
Utility: Online scholarly articles; links to other online publications, libraries, archives, museums, etc.

U.S. National Library of Medicine—
Internet Grateful Med
http://igm-01.nlm.nih.gov/index.html
Sponsor: U.S. government
Subject Matter: Library of medicine
Utility: Online documents about medicine, including historical articles.

U.S. Patent and Trademark Office
http://www.uspto.gov
Sponsor: U.S. Patent and Trademark Office
Subject Matter: Patent search
Utility: Access to all patents given by the U.S. federal government
Documentation: Patents (copies can be ordered)

WWW Virtual Library for the History
of Science, Technology & Medicine
http://www.asap.unimelb.edu.au/hstm/hstmove.htm
Sponsor: Australian Science and Archives Project
Utility: Hundreds of links to historical articles and sites; organized for easy reference; very good starting point

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EVALUATING INTERNET RESEARCH SOURCES

by Robert Harris, Southern California College

Note: The following is highly recommended reading for teachers whose students are using the Internet for History Day research. You may want to photocopy for students the summaries of the CARS Checklist for Research Source Evaluation and the Cafe (Challenge, Adapt, File, Evaluate) and discuss these issues in class, having students evaluate examples of information they have found on the Internet.

INTRODUCTION:
THE DIVERSITY OF INFORMATION

Information is a Commodity Available in Many Flavors

Think about the magazine section in your local grocery store. If you reach out with your eyes closed and grab the first magazine you touch, you are about as likely to get a supermarket tabloid as you are a respected journal (actually more likely, since many respected journals don't fare well in grocery stores). Now imagine that your grocer is so accommodating that he lets anyone in town print up a magazine and put it in the magazine section. Now if you reach out blindly, you might get the *Elvis Lives With Aliens Gazette* just as easily as *Atlantic Monthly* or *Time*.

Welcome to the Internet. As I hope my analogy makes clear, there is an extremely wide variety of material on the Internet, ranging in accuracy, reliability and value. Unlike most traditional information media (books, magazines, organizational documents), no one has to approve the content of Internet material before it is made public. It's your job as a searcher, then, to evaluate what you locate, in order to determine whether it suits your needs.

Information Exists in a Continuum of Reliability and Quality

Information is everywhere on the Internet, existing in large quantities and continuously being created and revised. This information comes in many forms (facts, opinions, stories, interpretations, statistics) and is created for many purposes (to inform, to persuade, to sell, to present a viewpoint, and to create or change an attitude or belief). For each of these various forms and purposes, there are many levels of quality or reliability. It ranges from very good to very bad and includes every shade in between.

GETTING STARTED:
SCREENING INFORMATION

Pre-evaluation

The first stage of evaluating your sources takes place before you do any searching. Take a minute to ask yourself what exactly you are looking for. Do you want facts, opinions (authoritative or just anyone's), reasoned arguments, statistics, narratives, eyewitness reports, descriptions? Is the purpose of your research to get new ideas, to find either factual or reasoned support for a position, to survey opinion, or something else? Once you decide on this, you will be able to screen sources much more quickly by testing them against your research goal.

Select Sources Likely to be Reliable

Becoming proficient at this will require experience, of course, but even a beginning researcher can take a few minutes to ask, "What source or what kind of source would be the most credible for providing information in this particular case? Which sources are likely to be fair, objective, lacking hidden motives, showing quality control?" It is important to keep these considerations in mind, so that you will not simply take the opinion of the first source or two you can locate. By thinking about these issues while searching, you will be able to identify suspicious or questionable sources more readily. With so many sources to choose from in a typical search, there is no reason to settle for unreliable material.

Source Selection Tip

Try to select sources that offer as much of the following information as possible:

- Author's name
- Author's title or position
- Author's organizational affiliation
- Date of page creation or version
- Author's contact information
- Some of the indicators of information quality (listed below)

EVALUATING INFORMATION:
THE TESTS OF INFORMATION QUALITY

Reliable Information is Power

You may have heard that "knowledge is power," or that information, the raw material of knowledge, is power. But the truth is that only some information is power: reliable information. Information serves as the basis for beliefs, decisions, choices and an understanding of our world. If we make a decision based on wrong or unreliable information, we do not have power—we have defeat.

Source Evaluation is an Art

Source evaluation—the determination of information quality—is something of an art. That is, there is no single perfect indicator of reliability, truthfulness or value. Instead, you must make an inference from a collection of clues or indicators, based on the use you plan to make of your source. If you want reliable facts, then using facts from a source that meets certain criteria of quality will help assure the probability that those facts are indeed reliable.

The CARS Checklist

The CARS Checklist (Credibility, Accuracy, Reasonableness, Support) is designed for ease of learning and use. Few sources will meet every criterion on the list, and even those that do may not possess the highest level of quality possible. But if you learn to use the criteria in this list, you will be much more likely to separate the high-quality information from the poor-quality information.

THE CARS CHECKLIST FOR INFORMATION QUALITY

Credibility

Because people have always made important decisions based on information, evidence of authenticity and reliability—or credibility, believability—has always been important. If you read an article saying that the area where you live will experience a major earthquake in the next six months, it is important that you know whether or not to believe the information. Some questions you might ask would include: What about this source makes it believable (or not)? How does this source know this information? Why should I believe this source over another? As you can see, the key to credibility is the question of trust.

There are several tests you can apply to a source to help you judge how credible and useful it will be:

Author's Credentials: The author or source of the information should show some evidence of being knowledgeable about the subject at hand, reliable and truthful. Consider, for example, the author's background, training, and organizational affiliation.

Evidence of Quality Control: Most scholarly journal articles pass through a peer review process, whereby several readers must examine and approve content before it is published. Statements issued in the name of an organization have almost always been seen and approved by several people. (But note the difference between, "Allan Thornton, employee of the National Oceanographic and Atmospheric Agency, says that a new ice age is near," and "The National Oceanographic and Atmospheric Agency said today that a new ice age is near." The employee is speaking for himself, whereas a statement in the name of the NOAA represents the official position of the NOAA.)

Indicators of a Lack of Credibility: You can sometimes tell by the tone, style or competence of the writing whether or not the information is suspect. Here are a few clues:

- Anonymity
- Lack of quality control
- All negative information
  (If all the reviews are critical, be careful.)
- Bad grammar or misspelled words

Most educated people use grammar fairly well and check their work for spelling errors. An occasional split infinitive or comma in the wrong place is not unusual, but more than two or three spelling or grammar errors is cause for caution, at least.

Accuracy

The goal of the accuracy test is to assure that the information is actually correct: up to date, factual, detailed, exact and comprehensive. For example, even though a very credible writer said something that was correct 20 years ago, it may not be correct today. Similarly, a reputable source might be giving up-to-date information, but the information may be only partial and not give the full story. Here are some concepts related to accuracy:

Comprehensiveness: Any source that presents conclusions or that claims (explicitly or implicitly) to give a full and rounded story should reflect the author's intentions of completeness and accuracy. In other words, the information should be comprehensive. Some writers argue that researchers should be sure that they have "complete" information before making a decision or that information must be complete. But with the advent of the information age, such a goal is impossible, if by "complete" we mean all possible information. No one can read 20,000 articles on the same subject before coming to a conclusion or making a decision. And no single piece of information will offer the truly complete story—that's why we rely on more than one source. On the other hand, an information source that deliberately leaves out important facts, qualifications, consequences or alternatives may be misleading or even intentionally deceptive.

Audience and Purpose: For whom is this source intended and for what purpose? If, for example, you find an article, "How Plants Grow," and young children are the intended audience, then the material may be too simplified for a college botany paper. More important to the evaluation of information is the purpose for which the information was created. For example, an article titled, "Should You Buy or Lease a Car?" might have been written with the purpose of being an objective analysis, but it may instead have been written with the intention of persuading you that leasing a car is better than buying. In such a case, the information will most likely be highly biased or distorted. Such information is not useless, but the bias must be taken into consideration when interpreting and using the information. (In some cases, you may need to find the truth by using only biased sources, some biased in one direction and some biased in the other.) Be sure, then, that the intended audience and purpose of the article are appropriate to your requirements or at least clearly in evidence so that you may take them into account. Information pretending to be objective but possessing a hidden agenda of persuasion or a hidden bias is among the most common kind of information in our culture.

Indicators of a Lack of Accuracy:

In addition to an obvious tone or style that reveals a carelessness with detail or accuracy, there are several indicators that may mean the source is inaccurate, either in whole or in part:

- No date on the document
- Vague or sweeping generalizations
- Old date on information known to change rapidly
- Very one-sided view that does not acknowledge opposing views or respond to them

Reasonableness

The test of reasonableness involves examining the information for fairness, objectivity, moderateness and consistency.

Fairness: Fairness includes offering a balanced, reasoned argument, not selected or slanted. Even ideas or claims made by the source's opponents should be presented in an accurate manner. Pay attention to the tone and be cautious of highly emotional writing. Angry, hateful, critical, or spiteful tones often betray an irrational and unfair attack rather than a reasoned argument.

Objectivity: There is no such thing as pure objectivity, but a good writer should be able to control his or her biases. Be aware that some organizations are naturally not neutral. For example, a professional anti-business group will find, say, that some company or industry is overcharging for widgets. The industry trade association, on the other hand, can be expected to find that no such overcharging is taking place. Be on the lookout for slanted, biased, politically distorted work.

Moderateness: Moderateness is a test of the information against how the world really is. Use your knowledge and experience to ask if the information is really likely, possible or probable. If a claim being made is surprising or hard to believe, use caution and demand more evidence than you might require for a lesser claim.

It is important, of course, to remember that some truths are spectacular and immoderate. Do not automatically reject a claim or source simply because it is astonishing. Just be extra careful about checking it out.

Consistency: The consistency test simply requires that the argument or information does not contradict itself. Sometimes when people spin falsehoods or distort the truth, inconsistencies or even contradictions show up. These are evidence of unreasonableness.

World View: A writer's view of the world (political, economic, religious—including anti-religious—and philosophical) often influences his or her writing profoundly, from the subjects chosen to the slant, the issues raised, issues ignored, fairness to opponents, kinds of examples, and so forth.

Indicators of a Lack of Reasonableness: Writers who put themselves in the way of the argument, either emotionally or because of self interest, often reveal their lack of reasonableness. If, for example, you find a writer reviewing a book he opposes by asserting that "the entire book is completely worthless claptrap," you might suspect there is more than a reasoned disagreement at work. Here are some clues to a lack of reasonableness:

- Intemperate tone or language: "stupid jerks," "shrill cries of my extremist opponents"
- Overclaims: "Thousands of children are murdered every day in the United States."
- Sweeping statements of excessive significance: "This is the most important idea ever conceived!"
- Conflict of Interest: "Welcome to the Old Stogie Tobacco Company Home Page. To read our report, 'Cigarettes Make You Live Longer,' click here"; or "The products our competitors make are dangerous and bad for your health."

Support

The area of support is concerned with the source and corroboration of the information. Much information, especially statistics and claims of fact, comes from other sources. Citing sources strengthens the credibility of the information. (Remember this when you write a research paper.)

Source Documentation or Bibliography: Where did this information come from? What sources did the information creator use? Are the sources listed? Is there a bibliography or other documentation? Does the author provide contact information in case you wish to discuss an issue or request further clarification? What kind of support for the information is given? How does the writer know this? It is especially important for statistics to be documented. Otherwise, someone may be just making up numbers.

Corroboration: See if other sources support this source. Even in areas of judgment or opinion, if an argument is sound, there will probably be a number of people who adhere to it or who are in some general agreement with parts of it. Whether you're looking for a fact (like the lyrics to a song or the date of an event), an opinion (like whether paper or plastic is the more environmentally friendly choice), or some advice (like how to grow bromeliads), it is a good idea to triangulate your findings. That is, find at least three sources that agree. If the sources do not agree, do further research to find out the range of opinion or disagreement before you draw your conclusions. Corroboration is especially important when

Library of Congress Resources Available Online

The Library of Congress web site (http://www.loc.gov) offers a gateway to the many history resources and primary sources available online from the Library of Congress. Important History Day support materials for the theme *Science, Technology, Invention in History* can be found here, including:

Learning Page (http://lcweb2.loc.gov/learn)

This site provides organized help for students and teachers who wish to use the library's online resources. Go to "Search Guides" for assistance searching and to "Learn More About It!" to find resource summaries, education-related examples and sample searches from American Memory collections that may help you with your History Day research work.

THOMAS:
Legislative information on the internet (http://thomas.loc.gov)

Search for science, technology and invention information from the 103rd Congress forward.

Research and Reference (http://lcweb.loc.gov/rr/research.html)

Find out about the special holdings of library reading rooms and special services from their reference desks. Search the "Science Tracer Bullets Online" (http://lcweb2.loc.gov/sctb) for bibliographies on science and technology topics.

American Memory (http://memory.loc.gov)

Find American history primary source photographs, documents, pamphlets, manuscripts and more in the 33 historical collections currently online. Special presentations and time lines will help you tap into the most useful information in each collection. Search across the collections or within a collection related to your History Day project. Some American Memory collections that include primary sources on science, technology and invention are:

- America's First Look into the Camera: Daguerreotype Portraits and Views, 1839–1862
- Around the World in the 1890s: Photographs from the World's Transportation Commission, 1894–1896
- Color Photographs from the Farm Security Administration and the Office of War Information, ca. 1938–1944
- The Evolution of the Conservation Movement, 1850–1920
- Inside an American Factory: Films of the Westinghouse Works, 1904
- Map Collections: 1639–1988
- Taking the Long View: Panoramic Photographs, ca. 1851–1991
- Touring Turn-of-the-Century America: Photographs from the Detroit Publishing Company, 1880–1920
- Words and Deeds in American History

Exhibitions (http://lcweb.loc.gov/exhibits/)

Visit online versions of library exhibits about people and cultures.

you find dramatic or surprising information (information failing the moderateness test).

Indicators of a Lack of Support: As you can readily guess, the lack of supporting evidence provides the best indication that there is indeed no available support. Be careful, then, when a source shows problems like these:

- Numbers or statistics presented without an identified source for them
- Absence of source documentation when the discussion clearly needs such documentation
- You cannot find any other sources that present the same information or acknowledge that the same information exists (lack of corroboration)

Summary of the CARS Checklist for Research Source Evaluation

Credibility: trustworthy source, author's credentials, evidence of quality control, known or respected authority, organizational support. Goal: an authoritative source, a source that supplies some good evidence that allows you to trust it.

Accuracy: up to date, factual, detailed, exact, comprehensive, audience and purpose reflect author's intentions of completeness and accuracy. Goal: a source that is correct today (not yesterday), a source that gives the whole truth.

Reasonableness: fair, balanced, objective, reasoned, no conflict of interest, absence of fallacies or slanted tone. Goal: a source that engages the subject thoughtfully and reasonably, a source concerned with the truth.

Support: listed sources, contact information, available corroboration, claims supported, documentation supplied. Goal: a source that provides convincing evidence for the claims made, a source you can triangulate (find at least two other sources that support it).

CAFE SOURCE EVALUATION

Here is one last piece of advice to help you live well in the world of information: Take your information to the Cafe (Challenge, Adapt, File, Evaluate).

Challenge: Challenge information and demand accountability. Stand right up to the information and ask questions. Who says so? Why do they say so? Why was this information created? How is it known to be true? Is it the whole truth? Is the argument reasonable? Who supports it?

Adapt: Adapt your skepticism and requirements for quality to fit the importance of the information and what is being claimed. Require more evidence for stronger claims.

File: File new information in your mind rather than immediately believing or disbelieving it. Don't come to a decision too quickly. It is fine simply to remember that someone claims XYZ to be the case. You need not worry about believing or disbelieving the claim right away. Wait until more information comes in, you have time to think about the issue, and you gain more general knowledge.

Evaluate: Evaluate and re-evaluate regularly. New information or changing circumstances will affect the accuracy and hence your evaluation of previous information. Recognize the dynamic, fluid nature of information. The saying, "change is the only constant," applies to much information, especially in technology, science, medicine and business.

For a complete version of this article, see: Harris, Robert. "Evaluating Internet Research Sources." 17 November 1997. Online at http://www.sccu.edu/faculty/R_Harris/evalu8it.htm.

Online Resources from the National Archives and Records Administration

The Digital Classroom
http://www.nara.gov/education/classrm.html

Research and National History Day
http://www.nara.gov/education/historyday/history.html

Research Tips
http://www.nara.gov/education/historyday/research.html

Student Activities for Navigating the National Archives
http://www.nara.gov/education/historyday/nhd.html

The Zimmermann Telegram
http://www.nara.gov/education/teaching/zimmermann/zimmerma.html

The Exhibit Hall
http://www.nara.gov/exhall/exhibits.html

President Richard Nixon's daily diary lists his telephone conversation with Apollo 11 astronauts on the moon, July 20, 1969
http://www.nara.gov/exhall/originals/apollo11.html

A People at War
http://www.nara.gov/exhall/people/people.html

Presidential Libraries
http://www.nara.gov/nara/president/address.html

Project Whistlestop (Harry S. Truman Presidential Library Digital Archive Project)
http://www.whistlestop.org

NARA Archival Information Locator (NAIL)
http://www.nara.gov/nara/nail.html
Note: NAIL is a searchable database that contains information about a wide variety of NARA holdings across the country. You can use NAIL to search record descriptions by keywords or topics and retrieve digital copies of selected textual documents, photographs, maps and sound recordings related to thousands of topics.

History of Aeronautics and Aerospace Resources from the National Aeronautics and Space Administration (NASA)

NASA provides numerous resources for history and social studies teachers to interest students in the history of the space program. The bulk of these materials may be downloaded from the Internet. See for example:

NASA: National Aeronautics & Space Administration (http://www.nasa.gov)
The central entry point to the massive amount of material available on the Internet from NASA.

NASA History Office Homepage (http://www.hq.nasa.gov/office/pao/History/history.html)
This page contains information on aeronautics and aerospace; space projects such as Mercury, Gemini, Apollo, Skylab, and Shuttle; astronaut and other key personnel biographies; and online historical publications. It also has a search engine available at the bottom of the main page to facilitate use.

Space Link (http://spacelink.nasa.gov/index.html)
This site in a central clearing house of educational materials produced by NASA.

NASA Image Xchange (http://nix.nasa.gov)
This page has free photographs available in a variety of resolutions for downloading and use by all.

TEACHING ABOUT SCIENCE, TECHNOLOGY, INVENTION WITH HISTORIC PLACES

Historic places provide excellent opportunities for teachers to enrich their history curriculum and guide students to exciting research opportunities related to the 1999 National History Day theme.

CURRICULAR AIDES

Teaching With Historic Places is a program of the National Park Service's National Register of Historic Places. Teachers can order short lesson plans that are ready to use in the classroom. Each lesson uses a place listed in the National Register of Historic Places, our nation's official list of cultural resources worthy of historic preservation. Lesson plans related to the history of science, technology and invention include:

- Saugus Iron Works: Life and Work at an Early American Industrial Site
- The Building of the Chesapeake and Ohio Canal
- Building America's Industrial Revolution: The Boott Cotton Mills of Lowell, Massachusetts
- Allegheny Portage Railroad: Developing Transportation Technology
- The Invention Factory: Thomas Edison's Laboratories
- Fort Hancock: A Bastion of America's Eastern Seaboard
- The Ohio and Erie Canal: Catalyst of Economic Development for Ohio
- Chattanooga, Tennessee: Train Town

Teachers can order these lesson plans from: Jackdaw Publications, P.O. Box 503, Amawalk, NY 10501; (800) 789-0020. In addition, teachers can learn how to create their own curriculum using a historic place in their area by ordering an "Author Packet" from the program.

For more information, write or call:
Teaching with Historic Places
National Register of Historic Places
National Park Service
1849 C Street, NW, Suite 400
Washington, DC 20240
(202) 343-9536

FINDING SITES IN YOUR AREA

A Good Place to Start: The World Wide Web:

Teachers can visit the National Park Service web site at http://www.cr.nps.gov/history/catsig.htm to find "Categories of National Significance and Parks That Illustrate Them." Categories include agriculture, architecture, environmental conservation, health/medicine, industry, maritime, military, science, technology and engineering, and transportation.

Industry and Engineering Historic Sites

HAER, the Historic American Engineering Record, documents historic sites with industrial and engineering significance. The documentation is housed at the Library of Congress and can be accessed at: http://lcweb2.loc.gov/ammem/hhhtml/habshome.html. Students can search by state for interesting sites in their area, such as steel mills, factories, foundries, canals, roads and railroads for which HAER has collected documents and photographs for researchers. Below is a list of selected recent HAER projects to give you an idea of the kind of sites the agency documents:

- Allegheny Oil Heritage Recording Project, Allegheny National Forest, Pennsylvania
- Continental Eagle Gin Company, Prattville, Alabama
- Hull-Oakes Lumber Company, Monroe, Oregon
- John A. Roebling Sons, Wire Rope Manufacturing Plant, Roebling, New Jersey
- Kalaupapa Water Collection System, Kalaupapa National Historical Park, Molokai, Hawaii
- Magnolia Plantation Cotton Gins & Presses, Natchitoches, Louisiana
- Mariscal Quicksilver Mine & Reduction Works, Big Bend National Park, Texas
- National Park Service Roads and Bridges Recording Program: Blue Ridge Parkway, Blowing Rock, North Carolina & Vinton, Virginia
- Natchez Trace Parkway, Mississippi/Tennessee
- Vicksburg National Military Park, Vicksburg, Mississippi
- Pennsylvania Historic Bridges-I, Harrisburg, Pennsylvania
- Southern Textile Project, Huntsville & Valley, Alabama, La Grange, Georgia
- Steam Tug *Hercules*, San Francisco Maritime National Historical Park

National Historic Landmarks Related to the History of Science and Technology

There are more than 68,000 properties listed in the National Register of Historic Places, including districts, sites, buildings, structures and objects that are significant in American history, architecture, archeology, engineering and culture. Among these are a smaller number of historic places designated as official "Historic Landmarks." Listed below are Historic Landmarks related to science and technology. For each of these landmarks, information is available on the landmark's historical significance. Some of the landmarks are privately owned and not open to the public. This list represents just a fraction of historic sites of interest to teachers. For more information on these or other historic places associated with science and technology, call the National Registry, History and Education office of the National Park Service at (202) 343-8175.

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ALABAMA:
Redstone Test Stand, Marshall Space Flight Center, Huntsville
Sloss Blast Furnace, Birmingham

ALASKA:
Leffingwell Camp Site, Flaxman Island

ARIZONA:
Lowell Observatory, Flagstaff
C. Hart Merriam Base Camp Site, Flagstaff
Desert Laboratory, Tucson

CALIFORNIA:
Room 307, Gilman Hall, Univ. of California, Berkeley
John Muir National Historic Site, Martinez
Hale Solar Laboratory, Pasadena
Edwin Hubble House, San Marino
George H. Scripps Memorial Marine Biological Laboratory, La Jolla
Rock Magnetics Laboratory, Menlo Park
Unitary Plan Wind Tunnel, Ames Research Center, Moffett Field
Mare Island Naval Shipyard, Vallejo

CONNECTICUT:
Armsmear, Hartford
Edward W. Morley House, West Hartford
Charles H. Norton House, Plainville
Russell Henry Cittenden House, New Haven
Connecticut Agricultural Experiment Station, New Haven
James Dwight Dana House, New Haven
Lafayette B. Mendel House, New Haven
USS *Nautilus* (submarine), Groton

DISTRICT OF COLUMBIA:
Army Medical Museum
Arts Club of Washington
Alexander Graham Bell Laboratory
Elliott Coues House
National Portrait Gallery
Old Naval Observatory
Smithsonian Building
David White House
Robert Simpson Woodward House

FLORIDA:
Cape Canaveral Air Force Station, Launch Pads and Mission Control Center, Cocoa Beach
Ybor City Historic District, Tampa

GEORGIA:
Warm Springs Historic District, Warm Springs

IDAHO
Experimental Breeder Reactor No. 1, National Reactor Testing Station, Arco

ILLINOIS:
University of Illinois Observatory, Urbana
Arthur H. Compton House, Chicago
Kennicotts Grove, Glenview
Frank R. Lillie House, Chicago
Robert A. Millikan House, Chicago
Room 405, George Herbert Jones Laboratory, University of Chicago, Chicago
John Deere House and Shop, Grand Detour
Rock Island Arsenal, Rock Island

INDIANA:
Indianapolis Motor Speedway, Speedway
Madame C.J. Walker Building, Indianapolis

LOUISIANA:
Big Oak and Little Oak Islands, New Orleans

MAINE:
Bowdoin (schooner), Castine

MARYLAND:
Rachel Carson House, Silver Spring
Gaithersburg Latitude Observatory, Gaithersburg
Elmer V. McCollum House, Baltimore
Ira Remsen House, Baltimore
Henry August Rowland House, Baltimore
William H. Welch House, Baltimore

MASSACHUSETTS:
Ernestina (schooner), New Bedford
Nathaniel Bowditch House, Salem
Elihu Thomson House, Swampscott
George D. Birkhoff House, Cambridge
Boston Manufacturing Company, Waltham
Percy Bridgman House, Cambridge
Reginald A. Daly House, Cambridge
William Morris David House, Cambridge
Reginald A. Fessenden House, Newton
Asa Gray House, Cambridge
Arthur D. Little, Inc. Building, Cambridge
Theodore W. Richards House, Cambridge
Count Rumford Birthplace, Woburn
Great Blue Hill Weather Observatory, Milton
George R. Minot House, Brookline
Arnold Arboretum, Boston
Boston Naval Shipyard, Boston
Ether Dome, Massachusetts General Hospital, Boston
Ellen H. Swallow Richards House, Jamaica Plain
Goddard Rocket Launching Site, Auburn

MICHIGAN:
Herbert H. Dow House, Midland
Fair Lane, Dearborn
Parke-Davis Research Laboratory, Detroit

MINNESOTA:
Mayo Clinic Buildings, Rochester

MISSOURI:
Sanborn Field and Soil Erosion Plots, University of Missouri, Columbia
Joseph Erlanger House, St. Louis
Missouri Botanical Gardens, St. Louis
Washington University Hilltop Campus Historic District, St. Louis

NEBRASKA:
Captain Meriwether Lewis (dredge), Brownville

NEVADA:
Leonard Rock Shelter, Lovelock

NEW HAMPSHIRE:
USS *Albacore*, Portsmouth

NEW JERSEY:
Lucy, the Margate Elephant, Margate City
Hadrosaurus Foulkii Leidy Site, Haddonfield
Abbott Farm Archaeological Site, Trenton
Albert Einstein House, Princeton
Joseph Henry House, Princeton
Horn Antenna, Holmdel
Speedwell Village, Morristown

NEW MEXICO:
Folsom Site, Folsom
Launch Complex 33, White Sands Missile Range
Los Alamos Scientific Laboratory, Los Alamos
Seton Village, Santa Fe
Trinity Site, Bingham

NEW YORK:
James Hall Office, Albany
New York Botanical Gardens, New York
Jethro Wood House, Poplar Ridge
Locust Grove, Poughkeepsie
George Eastman House, Rochester
Bell Telephone Laboratories, New York
Founders Hall, Rockefeller University, New York
Matthew Henson Residence, New York
Pupin Physics Laboratories, Columbia University, New York
General Electric Research Laboratory, Schenectady
Irving Langmuir House, Schenectady
John W. Draper House, Hastings-on-Hudson

NORTH CAROLINA:
USS *Monitor*, Cape Hatteras

OHIO:
Langstroth Cottage, Oxford
John B. Tytus House, Middletown
Rocket Engine Test Facility, NASA Lewis Research Center, Cleveland
Zero Gravity Research Facility (B-2), NASA
Lewis Research Center, Cleveland
Thomas Alva Edison Birthplace, Milan
Huffman Field, Wright-Patterson Air Force Base, Fairborn
Kirtland Temple, Kirtland
Hawthorn Hill, Oakwood
Charles F. Kettering House, Kettering
Wright Cycle Company and Printing Offices, Dayton
Wright Flyer III, Dayton

PENNSYLVANIA:
Charles B. Dudley House, Altoona
Humphry Marshall House, Marshallton
Pulpit Rocks, Huntington
Robert Fulton Birthplace, Quarryville
Mill Grove, Audobon
Gemeinhaus-Lewis David De Schweinitz Residence, Bethlehem
Joseph Priestly House, Northumberland
American Philosophical Society Hall, Philadelphia
John Bertram House, Philadelphia
Edward Drinker Cope House, Philadelphia
Hill-Physick House, Philadelphia
Rittenhouse Town Historic District, Philadelphia
Stenton, Philadelphia
Wagner Free Institute of Science, Philadelphia
Edward G. Acheson House, Monongahela

RHODE ISLAND:
Old Slater Mill, Pawtucket

SOUTH CAROLINA:
Middleton Place, Summerville
South Carolina State Hospital, Mills Building, Columbia
Borough House Plantation, Stateburg

TENNESSEE:
Rhea County Courthouse, Dayton
X-10 Reactor, Oak Ridge National Laboratory, Oak Ridge

TEXAS:
Lucas Gusher, Spindletop Oil Field, Beaumont

VERMONT:
Stellafane Observatory, North Springfield

VIRGINIA:
Benjamin Banneker, SW 9 Intermediate Boundary Stone, Arlington
Gen. William Mitchell House, Middleburg
Cyrus McCormick Farm and Workshop, Steeles Tavern
Eight-Foot High Speed Tunnel, Langley Research Center, Hampton
Full-Scale Tunnel, Langley Research Center, Hampton
Variable Density Tunnel, Langley Research Center, Hampton

WEST VIRGINIA:
Reb Radio Telescope, National Radio Astronomy Observatory, Green Bank

WISCONSIN:
University of Wisconsin Hall, Madison
Thomas A. Greene Memorial Museum, Milwaukee
Soldiers Home Reef, Milwaukee

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FACTORIES AND TECHNOLOGY IN INDUSTRIALIZING AMERICA

by Susan Smulyan, Brown University, and
Jodi Vandenberg-Daves, National History Day

Note: Portions of this lesson belong to a larger curriculum, "Discovering American History Through Science and Technology," developed by the Society for the History of Technology and the Lemelson Center for the Study of Invention and Innovation, National Museum of American History, Smithsonian Institution, and partially funded by the National Science Foundation. Additional curriculum materials from the project will be available on a World Wide Web site beginning in June 1998. Check: http://www.si.edu/lemelson.

GENERAL OVERVIEW

The three parts of this lesson examine the "modernization" of factories and of work practices in factories from different perspectives. The first two parts of the lesson examine the modernization of the textile industry in the North and South, and the third part has students look at "scientific management" as a prescription for thoroughly modernizing workers, machines and management practices.

A 1909 photograph of an immigrant girl working as a spinner in a Georgia cotton mill (Library of Congress).

In the textile industry, as in other industries, modernization meant a number of different things. What stimulated mill owners and managers to modernize was increased competition—between Northern mills and Southern mills, between U.S. factories and foreign producers, and between capital and labor. Modernizing textile production could involve new machinery, new factories, electrification, geographic relocation or the adoption of new management strategies. Or it could mean all of those things. How a person experienced modernization depended on whether he or she was a mill owner, an engineer or a worker for whom "keeping up to date" might mean joining a union.

In the textile industry new inventions expanded the production of textiles and dramatically changed the process of making cloth. For example, the high-speed spindle allowed for faster spinning; the drawing-in machine dramatically lowered the cost of warp preparation; and the automatic loom employed complex sensing devices that allowed the machine to stop itself if a thread broke and to reload a bobbin without skipping a beat. The automatic loom dramatically reduced the number of workers required in the factory, and all of these inventions posed new challenges of work pace, safety and skills for workers and managers.

PREPARATION

To prepare students for any or all of the three parts of this lesson, have them read chapters of their textbook related to industrialization and immigration in the late 19th and early 20th centuries. Include in your assignment sections on regional differences in the process of industrialization between the North and the South, and talk with students about the development of an industrial working class and a new managerial class during this time period.

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A mother and her sons doing piecework in their home in 1910 (Library of Congress).

Part I: Modernizing Cotton in New England

LESSON OBJECTIVES

Students will be able to:

1. Use interpretation of an oral history narrative to understand people's experiences with technology at work and at home during an intense period of American industrialization.

2. Develop interpretive connections between one person's experience with technology and larger historical trends, such as the mechanization of textile production and the role of factories in bringing together groups of people from different backgrounds who needed to learn how to work with new machines and with one another.

ACTIVITIES

Have students read the introduction to and excerpt from an oral history of one worker in the New England cotton mills. You may use the following questions to provoke discussion and develop historical analytical thinking:

1. From this excerpt from her oral history, what can we find out about the kinds of technology Antonia Bergeron used in her home and at work, and how she used those technologies? What other methods might you use to find out what kind of technology people used in their daily life at a given moment in history?

2. Where and how do you think Bergeron learned to use these different kinds of technology?

3. How do you think technology shaped Bergeron's life? For example, what role did her weaving skill play in the course of her life? What about her sewing machine? Her automobile?

4. What clues do you see here about the social life of immigrants who came to the mill? How did immigrants help one another at work and outside of work?

ENRICHMENT AND EXTENSION

1. Antonia Bergeron used the fruits of her labor—fabric—in her daily life. Was this true of most factory workers in the early 20th century? Students might investigate Henry Ford's reasons for instituting the famous "$5 day" for his workers, in part because he wanted them to be able to afford the products they built. How did other manufacturers at the time feel about this issue? How did workers feel?

2. What kinds of factory work are done by immigrant workers today? In factories today, do women still perform certain technical tasks while men perform others?

MODERNIZING COTTON IN NEW ENGLAND

The textile mills established at Lowell, Massachusetts, in 1822 were the first of the factory complexes to grow up on the major rivers of New England. Entrepreneurs hoping to duplicate the profits of those pioneering establishments developed the hydraulic power of the Connecticut River, the Saco River in Maine, and the upper reaches of the Merrimack River in New Hampshire for ever larger mill structures.

More and bigger mills called for more workers, and manufacturers readily turned to immigrant populations as a convenient source of cheap labor, foreigners who they hoped would be more docile than the New England mill girls of the 1830s, who formed unions to protect their interests.

By the 1880s, a second wave of industrial development prompted the creation of a predominantly immigrant work force in the New England mills, beginning first with the Irish, then French Canadians, and in the first decades of the 20th century, Italians. The following excerpt helps us appreciate the complexity of people's relationships to new technologies at work and at home in the industrial North.

Excerpt from* Amoskeag: Life and Work in an American Factory-City, *by Tamara Haraven and Randolph Langenbach (New York: Pantheon Books, 1978).

Antonia Bergeron started work in the Amoskeag Mills in 1895, when she was 15 years old, and continued until her first child was born. However, as she tells us, she went back into the mills when the family needed money. Here is how she remembered those days:

I came here in 1895; and in 1900, when the century began, I got married. I was twenty years old on the first of October, 1899; and I got married on January eighth. Before that, I worked in the mills and I wove bags. We started by giving two weeks of our time for nothing to learn how to spin cotton. They gave us two [spinning] frames, and we had $.20 per day. Then, when we were able to run an extra frame, they gave us $.10 more. That made $.30. I went up to $.50. Then I left. I learned to weave. I wove those round [burlap] bags.

My father was on the farm in Canada. He wasn't very rich. We were thirteen children; I was the seventh. I went to a small school in the village with only about ten children. My mother taught school there. We could read fluently, and we could spell....

After I finished high school, as they called it, the inspector came and said, "If you want to teach school, you'll have to do model teaching. I'll give you a small place, and you'll teach school to perhaps ten or twelve children. You'll start by showing them ABCD. It'll be very easy." But it was cold. In the morning, I knew that it was the schoolteacher who would have to get up and light the stove to heat the school before the children arrived. So when my neighbors from Lake St. John went to the U.S., I decided to go with them. I said to my father and mother, "You know, instead of teaching school here, I want to go to the United States." Of course it cost a little to let me go (not money cost, but feelings cost), but they knew the people well and they had faith in me.

We had a lot of misery when we arrived in Manchester. Had I known that we'd have all the misery here, I'd never have come. But it was too late.

I didn't know anyone when we arrived; and in a few weeks, I owed room and board money. Then I met a woman who had taught me school in Canada when I was small. She worked in the mills here. She helped me, found me a job in the mills. After five or six months, I started to get my affairs straightened out. My mother came up later with my little brother and my little sister. She bought some secondhand clothes, an old stove, some beds and mattresses, and she set up housekeeping. My mother would go wash clothes in the convent all day. She also cleaned at St. Augustine's Church. They had just newly built the church at that time. She'd get a dollar a day. She'd come home at night with her hands all burned with lye.

As time went on, we'd have another person come up, and another, and finally the whole family was here. My father gave his land to one of his sons and came up to the States, too, but he didn't stay....

When I was earning a dollar a day, it didn't take me long to get rid of it. For one thing, I had to buy a little to put on my back. You'd buy a piece of Indian cotton, $.05 a yard. Ma had a sewing machine, and we'd make little dresses. Sometimes it was muslin, and we'd make ourselves little ruffles, and Lord, did we have trouble! Today I'm blind, and I can do better than I did at that time.

In the mills, especially in the weave room, we didn't talk much. There's so much noise, you can't hear. That's why I never learned to speak English well. I like weaving. I always liked it. And after I was married, I often went in when I had the time. My husband also started by weaving, but he didn't like it and he became a shoemaker. He had a good trade in the shoe shop, but he would sometimes loaf three or four weeks when the company took inventory. That was their excuse. But we still had to eat. At times like that, I'd go in to weave. My husband didn't say much. He'd say, "Why do you want to go to work? You have no reason to go there. Why do you want to give yourself misery for nothing?" He didn't like it much, but when you came home with $20.00 then, it was worth about what $50.00 is today.

When we first came here we worked six days a week. We'd start at 7 a.m. and work till 6 p.m., on Saturdays till 4 p.m. That made it a long day, but in the mills we had an hour to eat. When you work and you have a lot of ambition, the time goes by fast. You never felt you'd done enough. When you think you didn't have enough money, you want to work to make more. We ran through the whole mill; you had to run all day. Today they no longer work in the mills. They don't earn their money. They get a lot of money, though. They've told me that they get big, big salaries.

Boys changing spools at a mill (National Archives and Records Administration).

At the Amoskeag Company, for a time the bosses were very fresh. The boss would chase the girls and slap their behinds, give them kicks in the rear end. They'd send them away, those whom they didn't like, and not pay them. A little while ago, I saw the second hand, Mr. L., on the street. He used to visit his daughter who lived upstairs from us. I recognized him. I said, "Get out of the way or I'll run you over." I said, "When we worked for you, you ran after us, you'd kick us. So if you don't get out of the way, I'll run you down with the car" [starts laughing]. The bosses were strict! Many times we were well treated, though. We must appreciate what they did for us. Just before the strike, the big strike that we had, my husband had loafed about six months. No one in my family worked. We were twelve in the house to eat. I said, "I guess I'll go in and weave." I went to the employment office. There was a Canadian man [the clerk in the employment office in charge of hiring French-Canadian workers]. He didn't even look at me. He looked up in the air and said to me, "Madam, we have no place for you. We're refusing people every day." I left without saying a word. I said to myself, "Yes, I'm going to go see the super." I went to the mills, and the super said, "Come tomorrow morning, and I'll give you some work. I'll make you a room girl." I didn't much like that, but when you're hungry, you have to take what you can get.

The second hands favored people because of nationality. Sometimes we'd have German third hands who favored their own people. At times you'd have to wait longer than others because they had to start other work before getting to yours. You'd say, "It seems to me that I went and got you for help before so-and-so," and they'd say, "Oh no, so-and-so came before you." That's what went on. But "real Americans," to speak, there weren't any working in the mills. The bosses were Americans and Irishmen.

There were Germans who were bosses, too. The Germans were more difficult. But after they like you they're OK. I started weaving next to a German woman, and she didn't want me there at all; but then when I left for the family way, she cried and gave me some nice gifts for the baby. After she started to know me, I started becoming sociable, and I did a little work to help her out. She was old, and I was young and fast. At noon I'd sew for her. When you had a big run and a thread was missing, you'd do it with a needle by hand. We had no right to let a run pass through longer than half a yard. Well, I'd do a little sewing at noon. After that, we were very good friends, myself and the old German woman.

When the Amoskeag closed, oh my God! It was awful. Then there were a lot on relief. I never was because we were not affected. Everything went slack everywhere. Business fell completely. Before that, I remember we used to go to the Amoskeag store, at the corner of Bridge Street, and buy big packages of cotton, flannel. I used to go a couple of times a year and dress up all my children for school. Cotton dresses! They used to have beautiful cotton here. Flannel to make underwear for the children. I made them pajamas. It was always homemade stuff. Sometimes we'd make the trip for nothing. We didn't get a chance to be waited on; it was packed with people. We never had to buy anything already made, except for shoes and socks. Everything was made from cotton from Amoskeag.

Part II: Factory Life and Labor in the Southern Cotton Mills

LESSON OBJECTIVES

Students will be able to:

1. Use a variety of oral history excerpts to piece together an understanding of the working environment of the Southern cotton mills as experienced by workers. Students will investigate issues of worker safety, work rhythms, workers' level of skills with machines, and the social organization of work in factories.
2. In conjunction with Part I of this lesson, relate the history of technology to the history of the workers who used the machines, observing that how people interacted with technology depended on their ethnicity, race, gender and/or age, with different patterns emerging in the North compared to the South.
3. Think critically about the relationship between people and machines in workplaces past and present.

ACTIVITIES

Have students read the introduction to and excerpts from oral histories of workers in Southern cotton mills. You may use the following questions to provoke discussion and develop historical and analytical thinking:

1. From your reading of these oral history excerpts, who "ran" these cotton mills? The machines? The owners or foremen? The workers? Divide the class into three sections. Have each gather evidence to support one point of view, and have the class debate this issue.
2. Some of these excerpts suggest that people thought machines and the work rhythms of the factory were demeaning to the workers. Other workers remember enjoying factory work. Why did some millworkers enjoy the work more than others? What were the benefits and costs of millwork for children? For men? For women?
3. How did children learn the various technical tasks involved in textile millwork? How and where do kids today learn about the technology they will someday use in the workplace? How much contact do you have with the technology your parents use on the job? If you have a job yourself, what kinds of technology do you encounter at work?
4. What kinds of safety issues did workers face in the Southern textile mills? How, when and why did laws governing worker safety come into being? What role did workers' activism play in bringing about these changes?
5. How did race affect who learned which kind of technology in the South? What role did ethnicity and race play in Northern industry?

ENRICHMENT AND EXTENSION

1. How do today's industries deal with the problem of making a workplace suitable for both machines and people?
2. Would consumers, past or present, be willing to pay more for their clothes and textile products in order that workers might have safer conditions? Why or why not? What about imported items from factories overseas?
3. What were factory life and industrial technology like in other countries as they industrialized? What difference did it make that many countries developed factory systems many decades later than the United States? (The bibliography at the end of this lesson suggests a few starting points for student research projects on technology and industrialization outside the United States.)
4. Consider the industry in your local community. When did it get started? Did your town or region attract new migrants or immigrants to work in the mills, mines, quarries, etc.? What kinds of machinery and technologies shaped the work lives of the people in your town? If your town did draw in migrants to work, what kinds of adjustments did they need to make to work in industry? Did they come from the farm and need to learn to use new machines and develop new skills? Did they take on new work hours? Did they have new concerns about safety at work?

FACTORY LIFE AND LABOR IN THE SOUTHERN COTTON MILLS

Most of the people who came to work in the cotton mills that sprang up in North Carolina, South Carolina, and Georgia were farm families, driven from the land by hard times. The rapid increase in the number of Southern mills after 1900 also created a labor shortage there, and factory owners actively recruited from the region's large population of tenant farmers. The following reminiscences document the make-up and experiences of this work force.

Few of the voices are African-American. Slaves had been used as operatives and machinists in some prewar Southern cotton mills in central and low country South Carolina. But the expansion of cotton culture in the 1840s and 1850s, and the consequent scarcity of plantation slave labor, made white farm families an attractive alternative for mill owners.

Moreover, after 1900, when cotton manufacturing became big business in the South, dependent on a steady supply of cheap labor, managers turned race prejudice to their advantage by assuring white laborers that blacks would only be employed in menial jobs.

Excerpts from* Like a Family: The Making of a Southern Cotton Mill World, *by Jacquelyn Dowd Hall, et al. (Chapel Hill, University of North Carolina Press, 1987).

NANNIE PHARIS remembered that in 1905 a labor agent persuaded her father to give up farming and to bring his 10 children with him to the new mill in Spray, North Carolina:

"[The agents] would come to our home, because there was so many of us. They needed help, hands in the mill. That's how we started. They got our father to move into town and we all went to work."

DAVE McCARNS wrote a poem about it:

"Lots of people with a good free will
Sold their homes and moved to the mill.
We'll have lots of money they said,
But every one got hell instead.
It was fun in the mountains rolling logs,
But now when the whistle blows we run like dogs."

CHESTER COPELAND compared factory work to farming:

"Robot-ing is my word for it—in the mill you do the same thing over and over again—just like on a treadmill. There's no challenge to it—just drudgery. The more you do, the more they want done. But in farming you work real close to nature. There's always something exciting and changing in nature. It's never a boring job. There's some dirty jobs in farming, but there's nothing you get more pleasure out of than planting, growing, and then harvesting. In other words, you get the four seasons just like there are in a person's life—the fall and winter and spring and summer."

ALICE HARDIN remembered the 1920s:

"We moved down on Guilty Creek and was living here, and the tornado come. It tore up everything we had, blowed away everything we had, half our house and everything. Then we moved to another place and we lived there for about two or three years, and then we moved to the Woodside cotton mill. Daddy had about five or six hands to go to work in the mill at one time. Things had got tough in the country the way they started doing, so he went and asked for a job, and they give us a job and a house. Farming, where you rented, was getting difficult to make a living. That's the reason we moved to the mill. Us children liked the mill work better, because when we worked our hours, we was off. We thought it was easier. We had more time to do what we wanted. I don't think my father liked it at all, because he had rather be on the farm."

EMMA WILLIAMS often went to the mill where her mother worked, to "help out":

"I'm sure I didn't work for the money. I just wanted to work, I reckon. Oodles of kids. All of us used to do it together. [We] didn't do much, and it was real fun. I guess maybe one reason that it was fun was because that was the only time we got with other children. When we stayed home, well, we stayed home."

GEDDES DODSON started out helping his father:

"When I was a little fellow, my daddy was a-working in the Poinsett Mill. He was a loom fixer. He'd run the weavers' looms through the dinner hour so they could go eat their dinner. We lived about a mile and a quarter from the mill, and I'd carry his lunch each day. He'd tell me to come on in the mill, and he made me fill his batteries while he run the weavers' looms—and I was just a little fellow. See, I knew a whole lot about the mill before I ever went in one."

GROVER HARDIN dropped out of school after the second grade:

"I started out in the mill—the main reason—to help my mother. She wanted me to go to school until I got in the fifth grade. I told her, 'you need the help worse than I need the education, because I can get it later on, or I can do without it.' And so I went to work as quick as I possibly could. I started in as a sweeper."

EVA HOPKINS recalled the working conditions:

"They didn't have air-conditioning in the mills and it was terribly hot. They wouldn't let you raise the windows very high: air would come in; it would make the ends come down. Sometimes they'd let you prop a bobbin under them. I'd put the window up at the end of my frame, then here'd come the section man along and take it down. When he'd leave and go off, I'd raise it again. I couldn't stand the heat."

ALLIE SMITH had learned from her older sister how to spin by the time she was 11:

"When we moved to Carrboro, I thought I could go in and help her, and I did. But Mr. Carr owned this cotton mill, and I hadn't been over here long when he came over and said I couldn't come in and help. I would have to be on the payroll, so they put me on the payroll. And I worked there, I don't know how long—several months—and they said I couldn't work unless my father signed me up for being twelve years old. Well, he wouldn't do it. He said he didn't want me to work. They put me out and wouldn't let me work. And then I got to be twelve, I went in and went to work."

ALICE EVITT liked working in the mill:

"They'd let you go in there seven, eight years old. I'd go in there and mess around with my sisters; they'd be spinning. I liked to put up the ends and spin a little bit, so when I got to be twelve years old, I wanted to quit school. So I just quit and went to work, and I was twelve years old!"

NAOMI TRAMMELL, an orphan, recollected going to work at the Victor Mill in Greer, South Carolina:

"Well, I didn't know hardly about mill work, but I just went in and had to learn it. Really, I had to crawl up on the frame, because I wasn't tall enough. I was a little old spindly thing. I wasn't the only one, there's a whole place like that. And they had mothers and daddies [but they] wasn't no better off than I was. They had to learn us, but it didn't take me long to learn. They'd put us with one of the spinners and they'd show us how. It was easy to learn—all we had to do was just put that bobbin in there and put it up."

NOISE CROCKETT, an African American who worked at the mill in Lando, South Carolina, for many years, recalled:

"Wasn't nothing in the picker room but the colored. The onliest white man in there was the boss man."

T.B. FITZGERALD, president of the Riverside Mills in Danville, Virginia:

"As regards colored people, we only employ them as sweepers, scourers, truck drivers, and in the dye house and picker rooms; we do not have them in the mills proper, except in the above-mentioned menial capacities."

MACK DUNCAN remembered job specialization:

"There's some jobs that women could run, some that's always been classed for men. Loom fixers in the weave room has always been men. And usually the weavers were either man or woman. It's always been that way with weaving. But now spinners in the spinning room, they were all women. No man wanted to spin. Men weren't going to spin. That was it."

MACK DUNCAN, again:

"The weave room was always wet. Back then, you had to have a lot of water in the weave room. The air wasn't conditioned the way it is now, scientifically; there was just water being sprayed out. It was atomized and sprayed out to make the weaving run." •

MARY THOMPSON enjoyed her work:

"My sister drawed in, and she was the one that taught me. Drawing-in was piecework; they paid you so much for a warp. Now anyone that come in there and didn't have nobody to teach them, had to pay somebody to teach them. They wouldn't hire you unless you could hire someone to teach you, because it was expensive to teach anyone. It'd take more skill. And the bosses couldn't teach you, because they didn't know it theirself.

"I loved drawing-in. I enjoyed it more than anything I've done. I tell you, lots of people would complain about the work, but honest to goodness, I'd rather draw in than eat when I was hungry. I liked piecework the best. That gives you more incentive to get interested in your work, to see how much you can do. I was always up to working late, getting in all the work I could. It was all piecework, and if I drewed in fast, I made more money. Somebody else fool around and go to the bathroom or sit around and talk and such as that. Why, they just lost their money. But I was out for getting all the money I could get. I really loved it. The only thing I ever done in my life that I really loved."

CARL THOMPSON recalled the dangers of working in cotton mills:

"It was pretty dangerous. You'd have to watch yourself. There were so many thing that you could do. Even cleaning up, if maybe your brush would get caught in a belt or pulley, it's going to jerk your hand. I've seen them jerked in the cards thataway and maybe get their whole arm and all broke and the skin pulled off, maybe slam through the bone.

"I'd seen so many get hurt on them, get their arms broke. That was when they had overhead pulleys, had the pulleys at the top of the mill. There was one man, his shirt or something or other got caught in that belt, and that belt throwed him to the top of the mill and busted his brains out. He just hit the ceiling of the mill. They had big beams up there, and he hit them, right at the back of his head. It killed him."

Labor agents often went to country fairs and similar events that drew people together, handing out leaflets to attract farm families into the mill. This is an example of one:

"The Pacolet Manufacturing Company, of Pacolet, S.C., can furnish steady employment for over 300 days in the year for boys and girls over 12 years old, men and women at average wages, as follows:

Experienced 12 to 16-year old boys and girls from $.50 to $1.25.

Experienced boys and girls over 16, and men and women, $.75 to $1.50.

Old men, 60 to 70 years old, $.75 to $1.

We want whole families with at least three workers for the mill in each family."

Part III: Scientific Management

LESSON OBJECTIVES

Students will be able to:

1. Use "prescriptive literature" from the past (documents that prescribe a change in current practices) to help them understand underlying relationships among people and between people and machines in the factory. (Students can learn a great deal about what Frederick Winslow Taylor describes as the average factory's "rule of thumb" practices by examining his prescriptions for change.)
2. Drawing on evidence from other sources (such as the preceding oral history excerpts and readings in secondary sources like the textbook), evaluate the validity of Taylor's claims about what scientific management could do for workers, managers and the general public, and how easily it could be implemented.
3. Experience the impact of new scientific management techniques on workers (and/or managers or members of the general public), either through simulating the introduction of scientific management into factory work or by taking on a historical persona.
4. Relate their understanding of scientific management in industrial America to present-day situations in workplaces and homes.
5. Understand how new machines and new management techniques together created the modern factory.

ACTIVITIES

1. Have students read an introduction to and examine the excerpt from Frederick Winslow Taylor's famous book, *Principles of Scientific Management*. You may use the following questions to provoke discussion and develop historical and analytical thinking.
   - Explain in your own words the basic principles of scientific management according to Taylor.
   - What kinds of work methods and social relationships at work was Taylor trying to replace?
   - Do you think scientific management worked as smoothly as Taylor imagined? Why or why not?
   - What do you think of Taylor's statement, "In this way, the true initiative of the workmen is better attained under scientific management than under the old individual plan"?
   - Why did Taylor believe it was important for managers to have an "accurate study of the motives which influence men"? (You might examine the development of "industrial psychology," a field of study strongly influenced by Taylor's ideas.)
   - What kinds of problems might arise from having one foreman replaced by eight? Would managers suggest such a tactic today? Why was Taylor enthusiastic about this approach at the time?
2. Have students experience scientific management firsthand. The "Beat the Clock" activity that follows the excerpt from Taylor's book offers an opportunity to turn your classroom into a factory for a class period, with interesting results.
3. Have students take on the persona of a worker, manager or concerned citizen writing a letter to a colleague—or in the case of the concerned citizen, writing to the local paper—about their experiences with scientific management. For example, the worker or manager might talk about challenges he or she faces in implementing this new system, and the concerned citizen might talk about any number of topics relating to industrialization, worker/management relations, etc.

ENRICHMENT AND EXTENSION

1. Taylor was one of many writers of his day who believed humanity could be elevated by the industrial revolution and the promise of bringing "science" to bear on many social and economic problems. Have students compare and contrast his ideas to some other famous reformers of the period, such as Jane Addams or James Watson (who had very contrasting ideas on how to use science to reform society).
2. Students might examine a critical period in the history of a given industry, perhaps in their community, in terms of scientific management. When and how were methods comparable to Taylor's methods introduced? Did the introduction of new machines lead to more workplace control on the part of managers? What kinds of skill levels were required of workers before and after the introduction of new machines or new management arrangements?
3. Consider the long-term impact of Taylor's ideas in another way. Have students ask their parents about management practices at their jobs. How much does standardization of worker tasks affect workers in today's offices, factories, homes, schools and farms? Are some workplaces easier to scientifically manage than others?
4. The cotton mills in the previous lesson were heavily mechanized places. Ask students to re-examine those materials and look for the kinds of management practices used in the mills and the kinds of challenges managers and workers there might face if more of Taylor's ideas were adopted.

SCIENTIFIC MANAGEMENT

By 1900, engineers and industrialists in America had developed new techniques for "rationalizing" the materials and processes of factory work. They had standardized, or made uniform, the dimensions of things like screw threads and pipe flanges; they had developed standard tests for engines and other equipment; and, perhaps most important of all, they had combined these elements into systems of mass production, capable of churning out hundreds of thousands of consumer goods like sewing machines or farm implements that could be sold cheaply because they were all made alike.

The only significant element in the factory apparently left untouched by these sweeping changes was the work force itself, which was still governed by older notions of skill and work pace. The managers of modernizing industry thus saw it as their central task to reorganize work into patterns better suited to new machines, and in the process to gain better control over the workplace and especially over the workers themselves. Even though many decades of industrial development had resulted in fewer autonomous workers with complex craft skills, in many cases factory workers' skills, knowledge and level of organization among themselves still gave them significant control over the production process prior to the introduction of scientific management.

Frederick Winslow Taylor was the leading figure in the movement to have management assume a complete knowledge of the production process and oversee every detail of the routine of the workplace. His *Principles of Scientific Management*, published in 1911, immediately became the classic text for industrial engineers, marching under the banner of efficiency, who saw work itself as the last element of modern industry that needed to be affected by the new technologies. Taylor's ideas were fairly simple and consisted of applying the principles of machine design to the work force. Any given task would be broken down into its component parts, and the physical movements to perform each part analyzed. On the basis of this information, worker skills could be tested and time limits could be set for the completion of tasks. Taylor then used this data to determine wages and bonuses.

For the American textile industry, which you read about in Parts I and II of this lesson, the application of Taylorism came bundled with the introduction of the automatic loom. Managers who invested in the new looms were immediately interested in reorganizing the work force around the new technology. Indeed, it was this combination of automatic machines and new management techniques that created the modern factory, in which control of the production process and of the workplace were dramatically different than anything that had gone before.

Excerpts from* Principles of Scientific Management, *by Frederick Winslow Taylor (New York: W. W. Norton, 1911).

The useful results [of scientific management] have hinged mainly upon (1) the substitution of a science for the individual judgment of the workman; (2) the scientific selection and development of the workman, after each man has been studied, taught, and trained, and one may say experimented with, instead of allowing the workmen to select themselves and develop in a haphazard way; and (3) the intimate cooperation of the management with the workmen, so that they together do the work in accordance with the scientific laws which have been developed, instead of leaving the solution of each problem in the hands of the individual workman. In applying these new principles, in place of the old individual effort of each workman, both sides share almost equally in the daily performance of each task, the management doing that part of the work for which they are best fitted, and the workmen the balance....

The development of a science sounds like a formidable undertaking....In most trades, the science is developed through a comparatively simple analysis and time study of the movements required by the workmen to do some small part of his work, and this study is usually made by a man equipped merely with a stop-watch and a properly ruled notebook. Hundreds of these "time-study men" are now engaged in developing elementary scientific knowledge where before existed only rule of thumb....The general steps to be taken in developing a simple law of this class are as follows:

First. Find, say, 10 or 15 different men (preferably in as many separate establishments and different parts of the country) who are especially skillful in doing the particular work to be analyzed.

Second. Study the exact series of elementary operations or motions which each of these men uses in doing the work which is being investigated, as well as the implements each man uses.

Third. Study with a stop-watch the time required to make each of these elementary movements and then select the quickest way of doing each element of the work.

Fourth. Eliminate all false movements, slow movements, and useless movements.

Fifth. After doing away with all unnecessary movements, collect into one series the quickest and best movements as well as the best implements.

This one new method, involving that series of motions which can be made quickest and best, is then substituted in place of the ten or fifteen inferior series which were formerly in use. This best method becomes standard, and remains standard, to be taught first to the teachers (or functional foremen) and by them to every workman in the establishment until it is superseded by a quicker and better series of movements. In this simple way one element after another of the science is developed.

In the same way each type of implement used in a trade is studied...after a time study has been made of the speed attainable with each of these implements, that the good points of several of them shall be united in a single standard implement, which will enable the workman to work faster and with greater ease than he could before. This one implement, then, is adopted as standard in place of the many different kinds before in use, and it remains standard for all workmen to use until superseded by an implement which has been shown, through motion and time study, to be still better.

There is another type of a scientific investigation which has been referred to several times in this paper, and which should receive special attention, namely, the accurate study of the motives which influence men. At first it may appear that this is a matter for individual observation and judgment, and is not a proper subject for exact scientific experiments. It is true that the laws which result from experiments of this class, owing to the fact that the very complex organism—the human being—is being experimented with, are subject to a larger number of exceptions than is the case with laws relating to material things. And yet laws of this kind, which apply to a large majority of men, unquestionably exist....In developing these laws, accurate, carefully planned and executed experiments, extending through a term of years, have been made, similar in a general way to the experiments upon various other elements which have been referred to in this paper.

Perhaps the most important law belonging to this class, in its relation to scientific management, is the effect which the task idea has upon the efficiency of the workman...There is absolutely nothing new in the task idea...the average workman will work with the greatest satisfaction, both to himself and to his employer, when he is given each day a definite task which he is to perform in a given time, and which constitutes a proper day's work for a good workman. This furnishes the workman with a clear-cut standard, by which he can throughout the day measure his own progress, and the accomplishment of which affords him the greatest satisfaction.

The writer has described in other papers a series of experiments made upon workmen, which have resulted in demonstrating the fact that it is impossible, through any long period of time, to get workmen to work much harder than the average men around them, unless they are assured a large and a permanent increase in their pay. This series of experiments, however, also proved that plenty of workmen can be found who are willing to work at their best speed, provided they are given this liberal increase in wages. The workman must, however, be fully assured that this increase beyond the average is to be permanent...This involves not only fixing for each man his daily task, but also paying him a large bonus, or premium, each time that he succeeds in doing his task in the given time....

The necessity for systematically teaching workmen how to work to the best advantage has been several times referred to. It seems desirable, therefore, to explain in rather more detail how this teaching is done. In the case of a machine-shop which is managed under the modern system, detailed written instructions as to the best way of doing each piece of work are prepared in advance, by men in the planning department....

These men of necessity spend most of their time in the planning department, because they must be close to the records and data which they continually use in their work, and because this work requires the use of a desk and freedom from interruption. Human nature is such, however, that many of the workmen, if left to themselves, would pay but little attention to their written instructions. It is necessary, therefore, to provide teachers (called functional foremen) to see that the workmen both understand and carry out these written instructions.

Under functional management, the old-fashioned single foreman is superseded by eight different men, each one of whom has his own special duties, and these men, acting as the agents for the planning department are the expert teachers, who are at all times in the shop, helping and directing the workmen....

One of these teachers (called the inspector) sees to it that he understands the drawings and instructions for doing the work. He teaches him how to do work of the right quality; how to make it fine and exact where it should be fine, and rough and quick where accuracy is not required—the one being just as important for success as the other. The second teacher (the gang boss) shows him how to set up the job in his machine, and teaches him to make all of his personal motions in the quickest and best way. The third (the speed boss) sees that the machine is run at the best speed and that the proper tool is used in the particular way which will enable the machine to finish its product in the shortest possible time....

Now, when through all of this teaching and this minute instruction the work is apparently made so smooth and easy for the workman, the first impression is that this all tends to make him a mere automaton, a wooden man. As the workmen frequently say when they first come under this system, "Why, I am not allowed to think or move without some one interfering or doing it for me!" The same criticism and objection, however, can be raised against all other modern subdivision of labor....

What really happens is that, with the aid of the science which is invariably developed, and through the instructions from his teachers, each workman of a given intellectual capacity is enabled to do a much higher, more interesting, and finally more developing and more profitable kind of work than he was before able to do. The laborer who before was unable to do anything beyond, perhaps, shoveling and wheeling dirt from place to place, or carrying the work from one part of the shop to another, is in many cases taught to do the more elementary machinist's work, accompanied by the agreeable surroundings and the interesting variety and higher wages which go with the machinist's trade. The cheap machinist or helper, who before was able to run perhaps merely a drill press, is taught to do the more intricate and higher priced lathe and planer work, while the highly skilled and more intelligent machinists become functional foremen and teachers. And so on, right up the line.

It may seem that with scientific management there is not the same incentive for the workman to use his ingenuity in devising new and better methods of doing the work, as well as in improving his implements, that there is with the old type of management. It is true that with scientific management the workman is not allowed to use whatever implements and methods he sees fit in the daily practice of his work. Every encouragement, however, should be given him to suggest improvements, both in methods and in implements. And whenever a workman proposes an improvement, it should be the policy of the management to make a careful analysis of the new method, and if necessary conduct a series of experiments to determine accurately the relative merit of the new suggestion and of the old standard. And whenever the new method is found to be markedly superior to the old, it should be adopted as the standard for the whole establishment. The workman should be given the full credit for the improvement, and should be paid cash premium as a reward for his ingenuity. In this way the true initiative of the workmen is better attained under scientific management than under the old individual plan....

In this connection, however, it is proper to again state that during the thirty years that we have been engaged in introducing scientific management there has not been a single strike from those who were working in accordance with its principles, even during the critical period when the change was being made from the old to the new....

Doubtless some of those who are especially interested in working men will complain because under scientific management the workman, when he is shown how to do twice as much work as he formerly did, is not paid twice his former wages, while others who are more interested in the dividends than the workmen will complain that under this system the men receive much higher wages than they did before....

It is not fair, however, to form any final judgment until all of the elements in the case have been considered. At the first glance we see only two parties to the transaction, the workmen and their employers. We overlook the third great party, the whole people—the consumers, who buy the product of the first two and who ultimately pay both the wages of the workmen and the profits of the employer.

The rights of the people are therefore greater than those of either employer or employee. And this third great party should be given its proper share of any gain. In fact, a glance at industrial history shows that in the end the whole people receive the greater part of the benefit coming from industrial improvements. In the past hundred years, for example, the greatest factor tending toward increasing the output, and thereby the prosperity of the civilized world, has been the introduction of machinery to replace hand labor....

The writer is one of those who believes that more and more will the third party (the whole people), as it becomes acquainted with the true facts, insist that justice shall be done to all three parties.

And the means which the writer firmly believes will be adopted to bring about, first, efficiency both in employer and employee and then an equitable division of the profits of their joint efforts will be scientific management, which has for its sole aim the attainment of justice for all three parties through impartial scientific investigation of all the elements of the problem. For a time both sides will rebel against this advance. The workers will resent any interference with their old rule-of-thumb methods, and the management will resent being asked to take on new duties and burdens; but in the end the people through enlightened public opinion will force the new order of things upon both employer and employee.

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Scientific Management "Beat the Clock" Activity

NATURE OF ACTIVITY

Students simulate factory work with simple tasks and experience the introduction of scientific management techniques by the teacher. Students then read the student essay and have a class discussion on the impact of mechanization on workers.

MATERIALS NEEDED

Supplies and tools needed for the task chosen by the teacher: a stopwatch; a "new tool" that makes the task faster; tokens to "pay" student workers.

INSTRUCTIONS

The teacher should choose some simple task requiring manual dexterity that may be facilitated by better tools or materials. The task should require no more than five minutes to complete.

Examples:

- Count a set number of toothpicks and tie in bundles with a set length of twine, then give rubber bands.
- Make multiple copies of something, then give carbon paper.
- Count a set number of beans into a jar, then give measuring cup to replace counting.

Use the following steps to coordinate the factory work exercise:

1. Divide students into pairs of "workers."
2. Show students example of finished product desired.
3. Give students materials and tools for task.
4. Allow pairs of students to decide for themselves how best to perform the task.
5. Tell students they are to work as quickly as possible while being accurate and neat. Be sure no one starts the task before you give the signal.
6. Give the start signal and time work with a stopwatch. Make note of the time required by the two fastest pairs of workers, but allow work to continue until all workers have completed the task.
7. Pay student workers a "piece rate" of two tokens per finished item.

Now enter the scientific manager (teacher assumes the role of the efficiency expert).

8. Explain that the best time in round one is now the "standard" that all workers must meet.
9. Have the fastest pair of workers—or the second fastest (which has the best quality?)—demonstrate how they perform the task while the rest of the class observes.
10. Analyze their method by listing on the board detailed descriptions of actions involved, placement of tools, materials, etc. Break the task down into as many components as possible. Leave the list on the board where all can see. Also add rules like "No Talking!"
11. All student workers now perform the task following the instructions exactly as listed on the board. Once again teacher times the task with a stopwatch.
12. Stop work when "standard" time has elapsed. Pay worker pairs who complete the task three tokens. Those with incomplete products receive one token.

(Note: If time is critical, the simulation may be ended here. Proceed to step 16, discussion.)

Now introduce "new technology" *(new tool of different material that will make the task easier and faster).*

13. Repeat steps 4 through 11, paying only one token per finished item in step 7. (The factory owner must offset capital improvement cost of new technology.)
14. Pay student pairs who complete the task within new standard time two tokens and "fire" the rest.
15. Allow all worker pairs who have both speeded up and adapted to new technology to "cash in" their tokens for some real reward (extra credit, special privilege, etc.). Point out that this is incentive for workers who are more productive.
16. Discussion: Ask students to discuss their experiences with this activity.
    - How did they feel about being scientifically managed?
    - What parallels can they draw between their experiences and those of workers under Taylor's new system?
    - Ask students about present-day versions of "scientific" approaches to technical tasks in workplaces (e.g. government, fast food industries, city planning, transportation) and at home. Students might think for example about recipes, dress patterns, technical manuals, and instructions for assembly of toys, furniture, etc.
    - Have students find examples of tools and machines that have been redesigned for efficiency.

Labor and the History of Technology in the United States
Resources from the George Meany Memorial Archives

The George Meany Memorial Archives (GMMA) documents the history of organized labor as championed by the American Federation of Labor (AFL: 1881–1955) and the Congress of Industrial Organizations (CIO: 1938–1955), which merged in 1955 to form the AFL-CIO.

Records can be found here on the social effects of technology, invention and science on workers and the working class, and on the changing nature of work between the late 19th century and the middle of the 20th century. Specific records that document effects of technological change include: the charter files of international unions, state federations, and central labor bodies affiliated with the AFL, CIO, and AFL-CIO; still images; posters and broadsides; film; federation publications such as pamphlets, official newspapers, and constitutional proceedings.

For a general overview of the holdings of the GMMA and the approximately 40 other labor-related archives, consult *Labor History Archives of the United States: A Guide for Researching and Teaching*, edited by Daniel J. Leab and Philip Mason (Detroit, Mich.: Wayne State University, 1992).

To find out more, contact the GMMA at (301) 431-5451 or ldeloach@capcon.net, or see their web site: http://www.georgemeany.com. Teaching aids and bibliography on labor history are available at the following web site: http://www.hnet.msu.edu/~labor/.

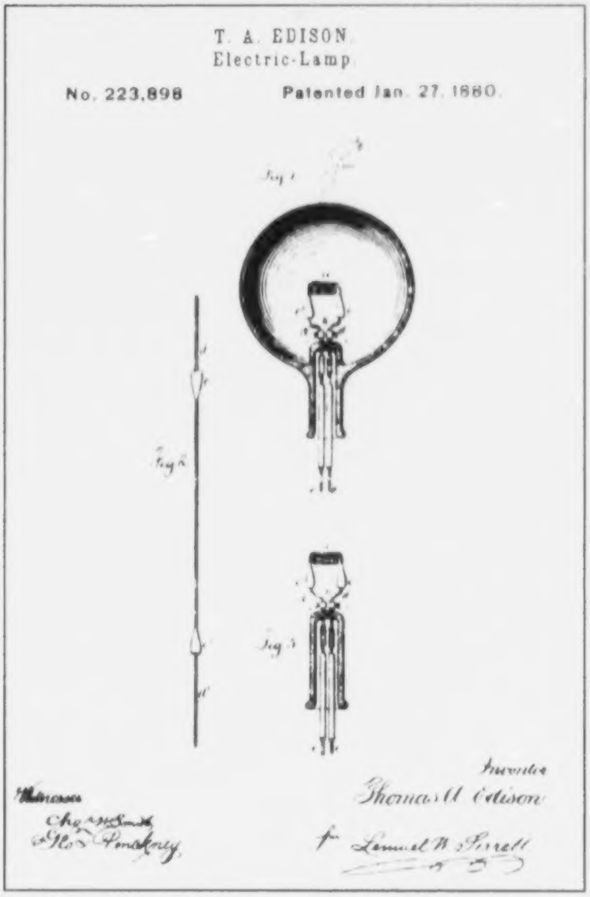
PATENTS AND INVENTION IN AMERICAN HISTORY

by Lee Ann Potter, National Archives and Records Administration

LESSON OBJECTIVES

Students will be able to:

1. Identify the role of the federal government in encouraging invention and protecting the rights of inventors.
2. Analyze patent drawings and evaluate their effectiveness in depicting an invention.
3. Place selected inventions in their historical context and determine their significance.



T.A. Edison's 1880 electric lamp (National Archives and Records Administration).

PREPARATION

Share with students the background information about the history of patents and patent drawings. Helpful background reading could focus on either the reasons for American interest in technology and invention in the eighteenth century (which led to the inclusion of the clause in the Constitution) or the especially prolific period of inventive activity between the last quarter of the nineteenth century and the first quarter of the twentieth.

ACTIVITIES

1. Provide students with a copy of the Constitution (one is available on the National Archives Website at: http://www.nara.gov/exhall/charters/constitution/conmain.html). Ask them to locate where patents are mentioned in the document and determine who has authority over them. Ask students: Considering the period in which the American nation was formed, and the issues facing the framers of the Constitution, why do you suppose the regulation of invention and the protection of a person's rights to his or her ideas were considered important enough to include in the Constitution? Was this protection of intellectual property an extension of property rights generally granted by the Constitution?
2. Display a transparency of each of the four patent drawings and ask students to compile basic data on the images by answering the following questions: What do you think this is? Is there anything familiar on this document? What is the date of this document? Whose name appears on the document?
3. Lead a class discussion of the documents using the following questions: What is the invention designed to do? How was this task accomplished prior to this invention? Do you suppose this invention sparked any subsequent ones? Did this invention require the creation of others?
4. Ask students to consider what skills were required of the inventor who developed each device, and what skills would be required to manufacture, market, and sell the product.
5. Assign each student to write a statement of reaction to one of the four patents at the time that it was first developed. Emphasize that their reaction can be either positive or negative. For example, students might take the role of a seamstress who feared that the sewing machine might replace her.
6. Ask students to imagine that one of these inventors is around today, and ask them to assume the role of Elias Howe, Thomas

Edison, Orville or Wilbur Wright, or Mrs. S.E. Saul. Ask students to write a monologue about the long-term impact of their invention, reflecting on how they originally imagined their invention would influence American society, and how it actually has.

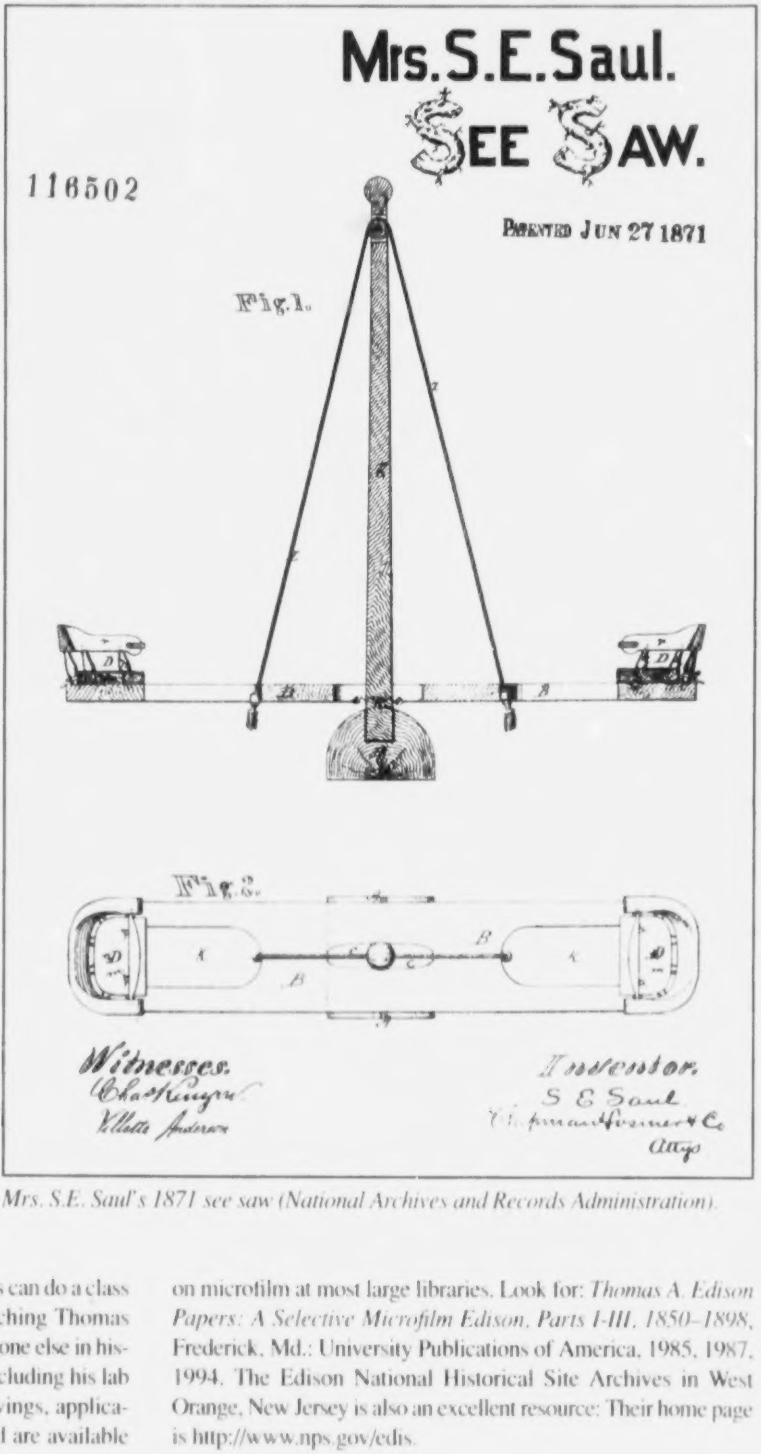
ENRICHMENT AND EXTENSION

1. These four patents relate primarily to the realms of transportation, industry, and recreation. Ask students to brainstorm about other realms and identify and research significant inventions in each. Some examples might include agriculture, medicine, architecture, and communication.

2. Encourage students to read about the role of government, industry, higher education or other entities involved in invention in another country and compare that country's support for invention to support in the United States (focusing on comparable time periods, such as the early history of a nation, or the late nineteenth century and early twentieth centuries.) Ask students to respond in writing to the following questions:
   - Did other countries have patent offices in the federal government?
   - Were inventions promoted and marketed in the same ways?
   - Was it unusual for a federal government to include a clause promoting invention in a founding document such as the Constitution?

3. Direct students to investigate and report on legal disputes related to patents. Examples include the 1840s dispute between Elias Howe and Isaac Singer over the sewing machine, litigation involving patents for barbed wire in the 1870s, the law suit between Henry Ford and George Selden concerning automobile patents in the early 1900s, and the 1980s case between Kodak and Polaroid over instant camera patents.

4. Numerous resources are available to document the history of famous individual inventors. Students can do a class project or create History Day projects by researching Thomas Edison, who was issued more U.S. patents than anyone else in history. Edison's papers for the period 1850–1898, including his lab notebooks, correspondence, patent sketches, drawings, applications and issued patents, have been published and are available on microfilm at most large libraries. Look for: *Thomas A. Edison Papers: A Selective Microfilm Edison, Parts I-III, 1850–1898*, Frederick, Md.: University Publications of America, 1985, 1987, 1994. The Edison National Historical Site Archives in West Orange, New Jersey is also an excellent resource: Their home page is http://www.nps.gov/edis.



Mrs. S.E. Saul's 1871 see saw (National Archives and Records Administration).

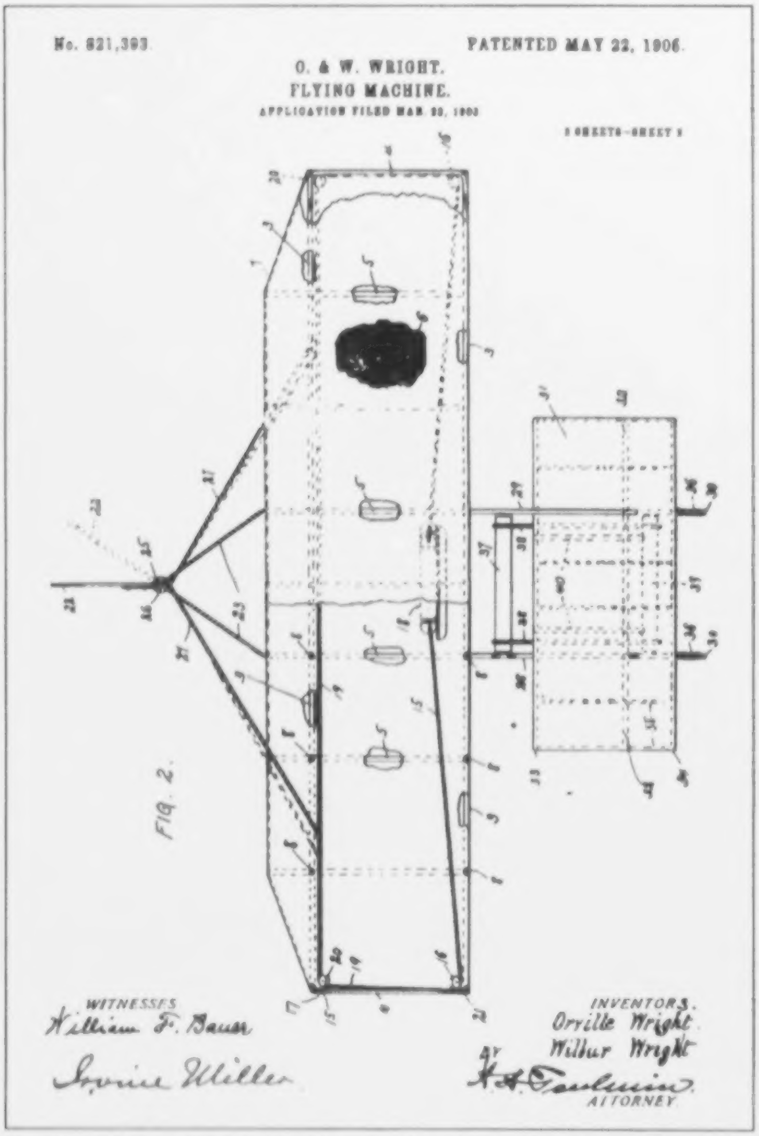
PATENTS AND INVENTION

"The Congress shall have Power… To promote the Progress of Science and useful Arts, by securing for limited Times to authors and Inventors the exclusive Right to their respective Writings and Discoveries…"

—U.S. Constitution, Article I, section 8.

In 1787 the framers of the Constitution recognized the importance of science and technology to the growth and development of the United States and granted Congress the power to pass laws relating to patents. The first patent law, enacted in 1790, established the Patent Board, composed of the Secretary of State, the Secretary of War, and the Attorney General.

Twelve years later, Congress established the Patent Office in the State Department, headed by the Superintendent of Patents. In 1836 Congress reorganized the Patent and Trademark Office and designated the Commissioner of Patents and Trademarks as the head official. The Patent and Trademark Office remained in the State Department until 1849, when it was transferred to the Department of the Interior, and in 1925 it was transferred to the Commerce Department, where it is today.

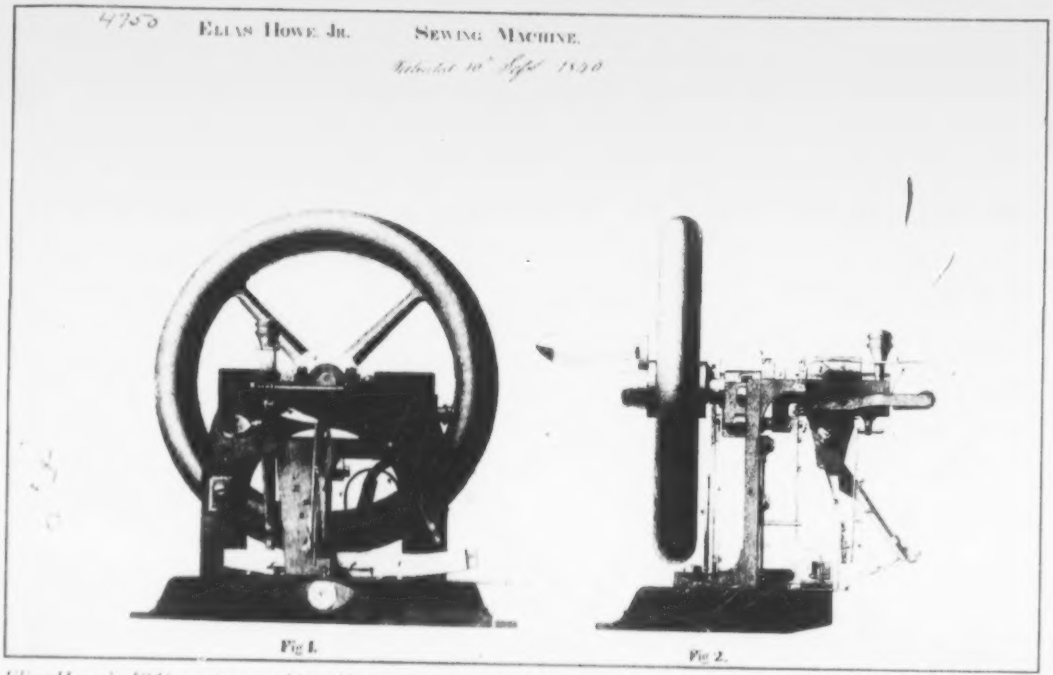


Orville and Wilbur Wright's 1906 flying machine (National Archives and Records Administration)

In addition to establishing the office and department responsible for patents, Congress passed laws governing the subject matter for which a patent may be obtained and the conditions necessary for an invention or design to be patented. The current law is a general revision which was enacted in 1952 and went into effect in 1953.

A patent for an invention grants the inventor "the right to exclude others from making, using, offering for sale or selling" the invention in the United States or importing the invention to the United States. Although a patent grants an inventor a monopoly for a period of years (today's patents are for 20 years), it also requires the inventor to disclose the details of his or her invention to the public.

As part of this disclosure, U.S. patent laws require applicants to submit drawings of their inventions and written descriptions called specifications. Until 1880 a model of the invention was also a mandatory part of the patent application. These requirements ensure that the invention will be understood by government officials, as well as other inventors, mechanics, manufacturers, patent agents, and judges and juries in courts in which legal cases involving patents might be tried. Patent drawings are not required to be "working drawings," nor is it necessary that they be drawn to scale. Examples of patent drawings (featured with this article) include the 1846 drawing for Elias Howe's sewing machine, the 1871 drawing of Mrs. S.E. Saul's see saw, the 1880 drawing of Thomas Edison's electric lamp, and the 1906 drawing of the Wright brothers' flying machine. These examples are just a few of the drawings submitted on behalf of the more than five and a half million U.S. patents that have been issued since the first patent was granted to Samuel Hopkins on July 31, 1790, for "making pot and pearl ashes."



Elias Howe's 1846 sewing machine (National Archives and Records Administration).

Since a U.S. patent does not protect an inventor outside this country, and a foreign patent does not protect an inventor in the United States, it is common for inventors to obtain patents in more than one country. As a result, significant foreign inventions are usually patented in the United States because it is an important world market. Thus, U.S. patent records contain not only the efforts of American inventors but, in many cases, the designs of foreign inventors as well.

Note: How to Find Patent Records

The records of the Patent and Trademark Office are found in Record Group 241 at the National Archives at College Park, Maryland. Pre-1838 patent drawings are with the cartographic records in the Special Media Archives Services Division, and post-1838 patent drawings are primarily with textual records in Civilian Records. Case files are arranged by patent number and contain drawings, specifications, correspondence with the examiner, and other documents.

Patent and Trademark Depository libraries are located throughout the United States. They receive current issues of U.S. patents and maintain collections of earlier-issued patents on microfilm. Their collections are available for use by the public free of charge.

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FAMILY HISTORY AND FLIGHT TECHNOLOGY

by Tim Hoogland, Minnesota Historical Society

LESSON OVERVIEW

In her book *History in the Schools*, author Hazel Hertzberg comments that, "If history is to have deep and lasting meaning to students, they must make it their own." Participation in History Day addresses this idea in two ways. First, the creative formats available to History Day students allow them to "make" history as they create exhibits, performances, papers and media presentations. But a second way for students to make history "their own" is to find personal connections to the past.

The broadcast of Alex Haley's *Roots* ignited a boom in the study of family history. Haley's novel demonstrated the drama of ordinary people living through extraordinary times. The key to the success of this work was Haley's ability to move beyond the genealogy of his family and explore a family's connection to the history that surrounded them.

Family history can be a great source of History Day topics. Students may assume that somehow their family exists "outside" of history, but by asking questions of parents, grandparents or great-grandparents they might find out some surprising information. The scientific discoveries, technological innovations and inventions of the 20th century have radically transformed the world. By studying these changes and their impact on individuals, it is possible to make connections between ordinary people and larger historical patterns and events.

This lesson starts with an object—a family heirloom—and uses it to connect the experiences of a young engineer during World War II to the technological transformation of American industry in the war effort. The narrative of the lesson also shows students how to connect family materials and research sources from other libraries and archives.

LESSON OBJECTIVES

The students will be able to:

1. Understand that their family has important connections to the past.
2. Appreciate family objects and papers as sources of historical information.
3. Understand the importance of the technology and inventions of the World War II era, especially those developed by industry during the war.

PREPARATION

Have students read and respond in discussion to the story of Herb Kuhlemeier. Discuss with students the impact changes in science, technology and invention may have had on their own family history in this century. Start by brainstorming with students about inventions that have had a significant impact on the 20th century. For homework, have each student conduct brief research on one invention, finding out for example the date of its invention and when it became popular and widely used. Then you might outline "generation jumps" of 25 years on the board (1975, 1950, 1925 and 1900) and define key technologies and inventions for each era.

ACTIVITIES

The following activities may be conducted by dividing the class into groups with separate tasks. Ask each group to report their findings to the rest of the class. You may also use these activities as individual assignments over several days.

1. Generational Interviews

Assign students the task of asking different generations of their family the following questions:

- What do you feel are the most important scientific discoveries, technologies or inventions in history?
- What scientific discoveries, technologies or inventions have had the greatest impact on your life?

Encourage students to have the person they interview provide at least three examples in his/her answer. Compile the results of the interviews in two charts, one for "history" and one for "life." The charts should have column headings for each generational group: peer, parent, grandparent and great-grandparent.

What trends do you notice for each question? How often do the "history" examples duplicate the "life" examples? Are there similarities in the responses for the different age groups? Do the responses differ if the interview subject lives in a rural, urban or suburban setting? Are there certain points in people's lives when new technologies tended to have especially important influence, such as upon entering the workplace or at the time of a medical crisis? Have students assess other variables that would shape the answers they receive.

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2. Historic Objects from Home

Ask students to bring an object to school that helps explain their personal or family history. You may want to focus on tools, household appliances or other objects that relate to the history of science, technology and invention. Provide each student with a 5x7 index card to create a piece of text that will accompany their object. At the top of the card the students should identify the object and date it (e.g. "Smith-Corona typewriter, 1974"). Next, the students should write a paragraph describing the *provenance*, or historical meaning, behind the object (e.g. "My mother received this typewriter as a high school graduation gift from her parents").

Display all of the objects with their text on a table or counter. After allowing the students to review the objects, have them work in groups to decide ways the objects could be grouped together in different categories. For example:

- Women and Work (example: iron)
- Tools of the Trade (example: carpentry level)
- Technology of Fun (example: Atari 64 video game)
- Gadgets (example: hand-held eggbeater)

Encourage students to think about the following questions:

- Who used this object?
- In what part of the country or world was it used and in what time period?
- How was it used?
- Where was it used? (home, workplace, etc.)
- Is it a keepsake with sentimental value?
- Who made it and how was it made? Using what kinds of technology?

Have the students report their groupings. Discuss the similarities and differences between the various student groups. How do differences in the student groupings reflect the way historians come to different conclusions when looking at the same material?

Have the students draw connections between their object and historical events or patterns of the time period. For example: How has the computer affected the sale of typewriters? (Do you think you will get one for high school graduation?) How did mass production make it possible for your grandfather to own the old fishing reel you found in his garage?

3. A Picture is Worth...?

Much of family history is documented by photographs. Unless a careful record has been kept of the time, place, people, occasion, and photographer involved in a photograph, you need to piece together clues to make sense out of the picture. The more background information you have about the people who are involved in the image, the easier it is to "read" the photograph.

Reproduce the photograph and student questions on page 49 for students to examine. Using information from the reading, "Herb, Honeywell and the Airplane Autopilot," have each individual student or group answer the questions and report their findings to the class. To help you lead the discussion, here is some background information along with a sample answer for each question:

Background Information: On August 17, 1942, Honeywell was awarded the Army-Navy "E" award for excellence in military production. This award was the highest commendation given to war production plants—only 3 percent of plants received it. The award ceremony took place at the autopilot factory in Chicago. In addition to the banner, each employee received an "E" pin to wear. Subsequent "E" awards would be noted by adding a star to the banner.

Awards like this were designed to use patriotism to inspire high-quality and high-volume wartime manufacturing. Previous wars were plagued by insufficient and shoddy material.

Alternatively, or in addition, you can have students bring in family photos of their own. You might have them bring in photos which reveal the kind of technology with which people interacted in their daily life. For example, there might be a picture of a grandmother near her brand new Frigidaire, or a great-uncle driving a car that by today's standards would be considered remarkably inefficient in its use of fuel.

Describe the image. [Black-and-white photograph of a group of people on a stage surrounding a banner that says, "Army-Navy" with the letter "E" in the middle. The picture was taken in a factory building. The building and stage are draped with government symbols such as an eagle and flag-like wall hangings. A sign promoting the sale of war bonds is partially visible. There is a podium with microphones.]

What type of people appear in the photograph? [Business people in suits, an Army officer, a Naval officer, an enlisted soldier from the Army Air Corps, women whose role is unclear, a young girl.]

When was this picture taken? If you do not know for certain, what clues would help you decide upon a date? [The actual date is August 1942. The wartime symbols, military uniforms and civilian clothing styles will help date the picture.]

Was the image taken spontaneously or posed? [Posed]

What was the photographer's purpose in taking this photograph? What does it tell you about the time period when it was taken? [It looks like a promotional photograph or the documentation of a news story. The image composition shows cooperation between the military and industry. The picture shows that this was a very patriotic time with strong concern about military issues.]

What, if any, information is written on the photograph that tells you more about it? [Army Navy E]

Additional questions about the pictures brought from home:

- Where did you find this photograph? What other objects, photos or documents were with the photograph when you found it? How might those materials provide you with additional clues in your interpretation of the photo?
- Can you use any information written on the photo (front or back) to tell you more?
- Who can tell you more about the story behind the photograph?
- What connections can you draw between this photograph and your family history?
- What connections can you draw between this photograph and larger historical events and patterns?

ENRICHMENT AND EXTENSION

1. Students can research the history of other inventions that developed from the conversion of American industry to military purposes during the war, such as radar technology, and explore their civilian uses in the postwar period.

2. Focusing on the story of one industry, such as plastics or steel production, students can research the impact of the conversion to military technology on the economic boom that followed World War II.

3. Contact the American Legion or the Veterans of Foreign Wars (VFW) to see if students can interview men who served in World War II bomber crews. What do they remember about the autopilot, the Norden bombsight, or military airplanes in general? (The film *Memphis Belle* dramatizes the experiences of the World War II bombardiers.)

4. Additional research projects can focus on domestic technology during the war, such as the widespread use of the radio, which kept Americans in touch with the day-to-day events of the war in ways never before possible. (Americans reportedly listened to the radio more than four hours a day on average during the war. Among the sounds they could hear when Edward R. Murrow broadcast from London were air raid sirens in the background.)

5. Students can examine the workplace experiences of "Rosie the Riveter" women in their community. These were women who had unprecedented opportunities to work in factories producing the machinery that supplied the war effort.

The military loaned the Minneapolis-Honeywell Company a B-17 bomber to help test and develop airplane technology. ***Herb Kuhlemeier*** *is in the middle of the group with his arms folded in front of his chest (Photo collections, Minnesota Historical Society).*

HERB, HONEYWELL AND THE AIRPLANE AUTOPILOT

History is made up of the connections of people to the past. The job of a historian is to tell the stories about those connections. In order to piece together the stories of the past, the historian depends on the records left behind by people and organizations. These records usually take the form of letters, documents, books, diaries or recordings. However, the "things" people leave behind can also be very important to the study of history, especially if you have background information to help you "read" them.

Objects help connect events and memories. This is why people purchase souvenirs, or mementos, when they go on vacation. A seashell, T-shirt or postcard may not cost very much, but each of them can be priceless when they help trigger memories of a special time and place.

History museums collect and display objects to tell stories about the past. Families take special care of objects that are considered to be "family heirlooms." In both cases the objects are being preserved in order to connect new generations to the stories and activities of their ancestors. Although objects will not speak to you, if you know enough about the people who made, owned or used them, you may discover surprising connections to history.

This story begins with a hat. The hat is made out of leather, has a fleece lining, and is machine stitched. Other features include a visor, ear flaps and a buckled chin strap. The materials and design of the hat can tell you a lot about the culture of the people who made or used it. In this case you could conclude that the hat belonged to someone who lived in a cold place where animals are used to make clothing. The machine stitching and the buckle show that this culture had factories as well.

Figuring out the type of hat and the date it was made requires some more detective work. There are no brand names to give you clues about where or when it was made. Looking through catalogs may help in your search, but without more information it is hard to arrive at firm conclusions.

What makes this hat different from an identical one you may find in an antique store is that we know its *provenance*. Provenance refers to the supporting information about the owner or user of an object. The more you know about an object, the easier it is to connect it to the stories of history.

At first glance you might guess that the hat belonged to an early airplane pilot. That is a good guess, but it is actually a motorcycle helmet from the 1930s. This object is not especially rare. It did not belong to a famous daredevil or movie star. What makes this helmet valuable is that there is supporting information about the life and work of its owner. This motorcycle helmet will help tell the story of a young man seeking his career and how the future of a company was changed by the technologies invented by its employees.

The owner of the motorcycle helmet was Herbert Kuhlemeier, who was raised in the small town of Rockford, Iowa, just outside of Mason City. Herb's thoughts on his early life were recorded in April of 1929 when he completed a senior class writing assignment that asked him to assess his life and talents up to that time. In his essay Herb commented on both the joys and isolation of rural life. He knew he did not want to be a farmer, but like most high school students, Herb did not have a clear picture of his future career. "It is my task to choose an occupation which will satisfy my ambitions," he wrote. "Perhaps my chance will be presented to me or perhaps I shall find it—whatever it may be." He closed his essay with the following summary of his skills and interests:

> *Due to the fact that I have always liked to read and have read quite a bit, I have always had a trend toward literature. Also I have always been interested in mechanics and things mechanical. This not leaving me in the bottom in mathematics and Physics, but my weakness is to be found along the line of Civics and Government altho [sic] I have no peculiar dislike for either.*

About the same time Herb was writing his essay, events were taking place that were important to shaping his future. In Minnea-

Herb Kuhlemeier posed for this high school graduation photo in 1929. *Shortly after that, he left Rockford to take radio electronics courses in Chicago (Courtesy Esther Bauman).*

This is the motorcycle helmet that Herb Kuhlemeier wore during the 1940s (Tim Hoogland).

polis the merger between the Minneapolis, Minn., Heat Regulator Company and Honeywell Heating Specialties was being completed. Each of these companies was a leader in the area of home heating control devices. The combined resources of the new Minneapolis-Honeywell Company were critical in saving it from the economic devastation suffered by other firms due to the stock market crash of 1929 and the Great Depression.

Economic hardship was a global phenomenon and was especially severe in Germany. The Great Depression increased the popularity of radical political parties, including the National Socialists led by Adolf Hitler. In 1929 the sales of his political manifesto, *Mein Kampf*, tripled. In the next 10 years Hitler and his followers rose to political power and plotted the conquest of Europe. Their plans transformed the German economy and focused industrial production on the technology of war.

In 1929 few people could imagine that the fates of an Iowa school boy, a heating control manufacturer and a budding dictator would be linked closely together. However, the German invasion of Poland in 1939 and the European war it created led the American government to increase military preparations. President Franklin Roosevelt rejected the argument made by isolationists that America could remain unaffected by the wars raging in Europe and Asia. He wanted the country to be ready if war came.

For most Americans the events in Europe were not their main concern. The Depression still lingered and unemployment remained high. After high school Herb Kuhlemeier followed his interest in "things mechanical" and traveled to Chicago to attend an electronics school. He returned to Iowa in 1931 to work in the radio business and eventually purchased a repair shop in Mason City. Even during the Depression the demand for radios, and their repair, was high. Herb made a steady living, and on August 28, 1934, he married his high school sweetheart, Esther, and they settled down to raise a family.

By the time Pearl Harbor was attacked on December 7, 1941, many American companies had started to produce military supplies. With America now in the war, the amazing transformation of the United States economy to wartime production proceeded rapidly. Refrigerator companies were making gun placements, automobile manufacturers were building tanks, and the Minneapolis-Honeywell Company completed work on a government request to develop automatic control systems for airplanes.

The invention of the airplane autopilot is linked to one of the most secret technologies of the American war effort—the Norden bombsight. The Norden bombsight, the optical device that a bombardier looked down to target bombs, was remarkable for its ability to increase the accuracy of high-altitude bombing. However, accuracy was still dependent on the pilot's skill in maintaining steady flight. The U.S. Army Air Forces turned to American industry to find ways to fly airplanes with more precise control. One of the companies they contacted was Minneapolis-Honeywell.

Honeywell engineers had demonstrated heating control devices for military airplanes but did not receive any government contracts for their work. However, the military soon realized that the technology used to control heat could also be applied to other purposes. The first military use of Honeywell control technology was to keep airplane cameras level as they took pictures of the ground.

When pilots had trouble flying with enough precision to keep the Norden bomb-

C-1 autopilots were manufactured in a Chicago factory. Here, a female worker tests the main control panel. The gyroscope that controlled the system was housed in the case next to her left hand (Photo collections, Minnesota Historical Society).

sight accurate, Honeywell engineers were asked to help solve the problem, drawing on their expertise in home heating technology. A household heating thermostat is a feedback control device. It senses changes in temperature and turns on the furnace if it gets too cold. Once the temperature has returned to the proper degree, the thermostat turns the furnace off. These same principles were used in the development of the airplane autopilot.

The engineers developed a device that would automatically correct the movement of an airplane that flew off course. This device became known as the C-1 autopilot. The key to the system was a gyroscope that could sense variations in course and speed and make adjustments well before a human pilot could do so. Once the autopilot was turned on, control of the airplane passed to the bombardier, who would make final flight changes as he peered through the Norden bombsight. The C-1 autopilot made it possible to achieve flight accuracy beyond human ability, and its success launched the new "Aero" Division of Minneapolis-Honeywell.

Invention of the C-1 autopilot and development of other wartime products such as tank periscopes, artillery sights and other equipment for airplanes caused dramatic changes for Honeywell. New factories required hundreds of employees. Engineers were needed to test and improve products. To meet these demands, companies were constantly in search of men and women to work on the homefront.

Herb's knowledge of electronics made him a very desirable employee for the war industries. Twice he tried to enlist in the army, and both times he was rejected because of his technical training. In the fall of 1943 he received a letter from Minneapolis-Honeywell inviting him to come to Minneapolis for an interview. Herb had been referred to the company by an employee who had worked with him in the radio business. He accepted a position in the Aero Division and there found his opportunity to serve in the war effort. In November of 1943 Herb Kuhlemeier sold his business and moved to Minneapolis. His wife and three children joined him the next summer.

Herb became part of the team of engineers who worked on the production of the C-1 autopilot and developed a variety of aeronautical instruments. With Honeywell facilities spread out in different parts of Minneapolis, Herb would ride his motorcycle from plant to plant as he worked on his projects. Having a motorcycle was also economical, since gas was rationed during the war.

Eventually Herb was assigned to the airport hangar as the chief electrical flight research engineer. There he worked on a B-17 bomber loaned to Honeywell by the Army Air Forces. Engineers used the bomber to test new devices as it made practice "bombing" runs over a small lake in northern Minnesota. Herb's key contributions to the company were the development of a gyro balancer that improved the production of the autopilot and the invention of a six-channel flight recorder that collected data from test airplanes. Herb worked as part of a team of engineers who refined the technology that would make an important invention—the autopilot—work efficiently and be widely used.

By the spring of 1945 the Allies were on the way to victory in both Europe and the Pacific. This achievement was due in a large part to the remarkable transformation of American industry to wartime production. Through scientific and technological innovation, American companies were able to supply the needs of a global war effort. Honeywell manufactured over 110,000 autopilots and related devices during the war. This was accomplished with such high quality standards that Honeywell was recognized with several Army-Navy "E" Awards for excellence in production.

Once the pilot switched to the autopilot, the bombardier took control of the airplane (Photo collections, Minnesota Historical Society).

Herb wore his "E" pin proudly. It symbolized the dedication of the men and women on the home front to winning the war and supplying the military with the tools it needed to do the job. The company newsletter for May 25, 1945, described how over 70,000 people attended an exhibit of Honeywell war products. Sadly, however, right below this article is the obituary for Herbert Kuhlemeier, who died at the age of 34. The sudden onset of pancreatic cancer cut short his career and left a widow with four children.

As he wrote about his future aspirations in his high school essay, Herb had these thoughts about service and sacrifice:

> *I believe he is truly American who helps others. I do not mean to work for a neighbor for a week and collect full wage, but to do the little things that one can do to help others solve a problem that bothers their hearts or souls or to help one on the right track who has been side tracked. I would like to do great things but I do not care to be a great man.*

Like millions of other Americans, Herb Kuhlemeier found a place to serve in the war effort and played a part in the transfor-

This advertisement for Norge refrigerators from the Ladies' Home Journal *of 1943 was designed to show the company's contributions to the war effort. Probably thinking ahead, to a time when their production would be refocussed on household appliances, companies like this one also hoped to keep customers loyal to their brands during wartime. (Minnesota Historical Society).*

mation of the Minneapolis-Honeywell Company. Technologies developed during World War II provided the foundation for new postwar businesses as civilian uses were found for military products. The autopilot and other instruments developed by the Aero Division were important to the rapid growth of commercial aviation. Further advances in these technologies also made Honeywell a leading supplier of control systems to the American space program.

It is hard to imagine that the founders of a company whose products were designed to control home heating would think of a time when their successors would help land men on the moon. But history is made out of the ability of individuals and organizations to adapt to change. Science, technology and invention shaped the future of engineers like Herb Kuhlemeier and companies like Honeywell. The stories of products like the C-1 autopilot demonstrate the historic results when individual inspiration and corporate resources are combined.

This story began with a hat, so it is fitting to end it that way too. The leather motorcycle helmet was given to me by my grandmother when I was 14 years old. I do not know why I was selected, but she just thought I should have it. I knew it belonged to the grandfather I never met and that he died when my mother was just six years old. Fortunately, the helmet followed me safely through high school and college and was still available when I learned about the other information that helped tell this story.

The information in this article is made up of family photographs and records combined with the corporate records Honeywell donated to the Minnesota Historical Society. I did not know at the time my grandmother gave me the hat that I would become a historian and have the opportunity to study the part my grandfather played in the war effort. Herb's family and the Honeywell Company cared about their history. They preserved information that will help other family members and researchers understand their place in history.

By telling this story using my own family history, I am hoping you will ask questions about the people in your family. History is about the connections among people, place and time; the lives of ordinary individuals are directly linked to extraordinary events. The impact of science, technology and invention on the history of your family is something for you to discover.

To learn more about this story on the World Wide Web, connect to the National History Day home page at http://www.thehistorynet.com/NationalHistoryDay.

RESOURCES:

National Park Service Sites Related to Aviation History:

- Crissy Field at Presidio of San Francisco,
  Golden Gate National Recreation Area
- Dayton Aviation Heritage National Historical Park,
  Dayton, Ohio
- Floyd Bennett Field, Gateway National Recreation Area,
  Brooklyn, New York
- Indiana Dunes National Lakeshore, Porter, Indiana
- Wright Brothers National Memorial,
  Kill Devil Hills, North Carolina

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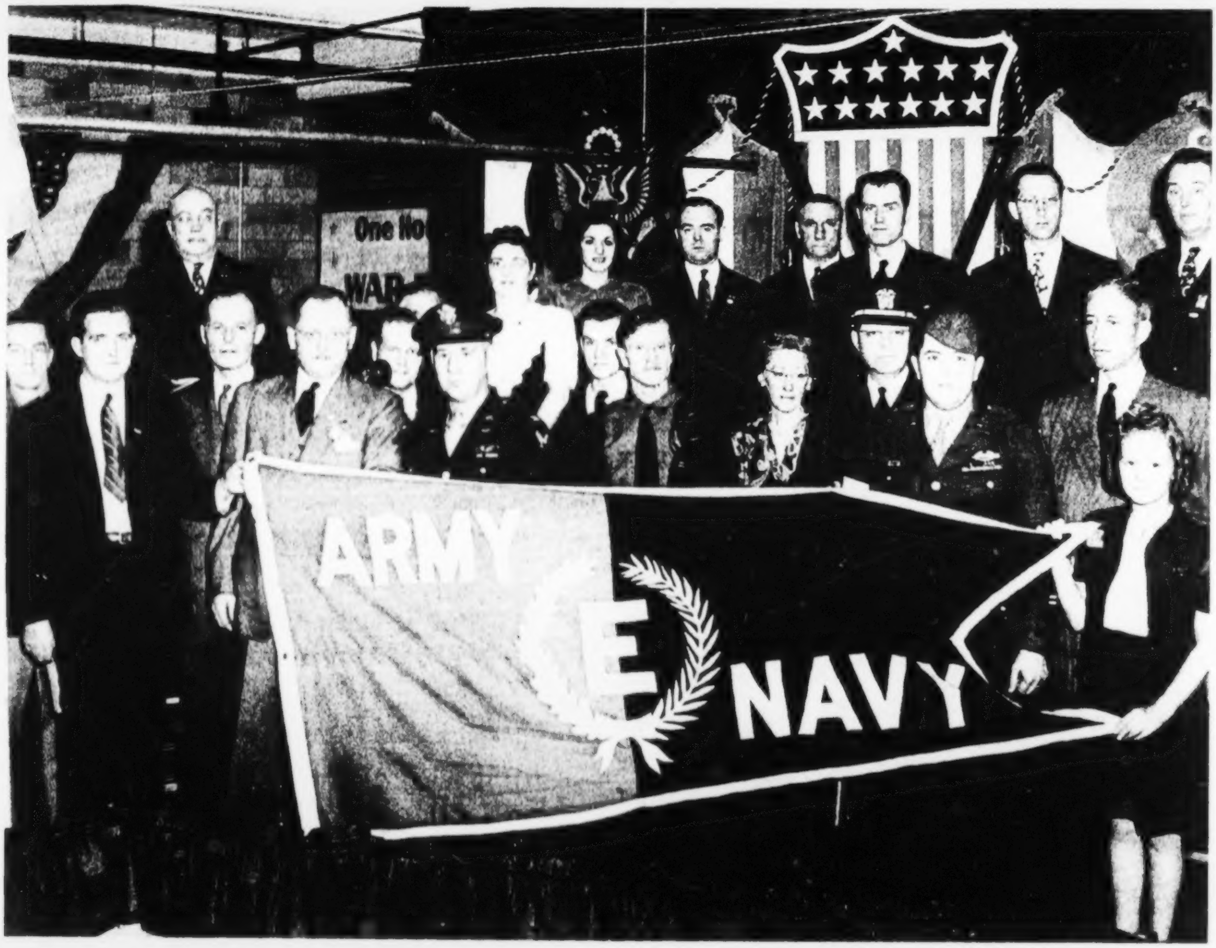


1. Describe the image.

2. What type of people appear in the photograph?

3. When was this picture taken? If you do not know for certain, what clues would help you decide upon a date?

4. Was the image taken spontaneously or posed?

5. What was the photographer's purpose in taking this photograph? What does it tell you about the time period when it was taken?

6. What, if any, information is written on the photograph that tells you more about it?

THE SCIENTIFIC REVOLUTION IN PRE-MODERN EUROPE

by Mitch Yamasaki, Ph.D., Chaminade University of Honolulu

Note: The following essay offers much food for thought for students seeking History Day topics. It provides background to many of the modern topics that will pop into students' minds when they think about science, technology and invention in history. The essay is based on careful interpretation of primary sources, which are available in translation for use in the classroom. At the end of the discussion the author points students to broad questions and themes about the long-term impact of the Scientific Revolution, some of the achievements of which are documented in the body of the essay.

The Scientific Revolution in pre-modern Europe produced a new way of conceptualizing and investigating the universe. Europeans stopped relying exclusively on ancient and church authorities to comprehend the cosmos. Instead, they came to believe that individuals could understand the natural world through direct observation, careful experiments and mathematical reasoning. These developments had a profound impact on the course of world history.

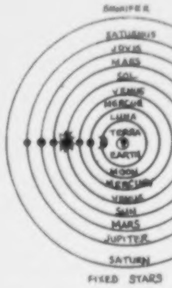
Renaissance Europe and the 'Age of Discovery'

The Scientific Revolution began during Europe's Renaissance. In this period, a thriving middle class tossed aside medieval preoccupations with supernatural forces and turned to secular concerns, such as making money and achieving fame. Free from feudal obligations that bound peasants and nobles to the land and to each other, members of the new urban middle class sought to develop their individual potentials. Leon Battista Alberti (1404–1472), the principal founder of Renaissance art theory, wrote, "Men can do all things if they will." The life of Leonardo da Vinci (1452–1519)—Renaissance painter, sculptor, musician, scientist and engineer—validated Alberti's claim.

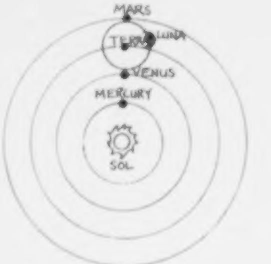
The Scientific Revolution also coincided with Europe's "Age of Discovery." Explorers from Christopher Columbus (1451–1506) to Captain James Cook (1728–1779) came across new plants, new animals and even new human beings that challenged traditional assumptions and conceptions of the world. At the same time, extended ocean travel required intense observations and mappings of the heavens. Not surprisingly, Europe's Scientific Revolution began0 in the field of astronomy.

Copernican Revolution

It began with Nicolaus Copernicus' simple proposition that the earth revolved around the sun instead of vice versa. Copernicus (1473–1543) was a respected Polish scholar and churchman who had earlier helped the Pope to revise the calendar (to the one we use today). Copernicus' heliocentric or solar system contradicted Ptolemy's geocentric or earth-centered system. Ptolemy was an ancient Greek astronomer whose ideas had been adopted by the academy and the Catholic Church. These institutions also adopted the mechanics of the ancient Greek philosopher Aristotle, who maintained that the stars and planets revolved around the earth in synchronized circular orbits.

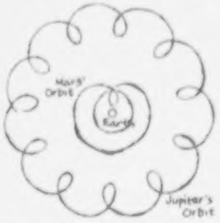


Ptolemy's Geocentric System



Copernicus' heliocentric system

The system of Ptolemy and Aristotle, however, did not correspond to astronomical observations. When astronomers plotted the orbits of the planets around the earth, some planets seemed to stop in their tracks and even loop backward across the sky. Today we know this is caused by the fact that the earth is also in motion. But medieval scholars insisted on the model of a stationary earth with orbiting stars and planets. They therefore charted a separate orbit for each planet that corresponded to observational data. Some of these orbits turned out to be extremely intricate. Only the moon's orbit came out as a simple circle.



Orbits of Mars and Jupiter based on a fixed Earth

These orbits bothered Copernicus because he possessed the modern notion that nature should be clear and simple to understand. He suspected that the problem lay in perspective. At this time, Renaissance artists were revolutionizing western art with the spirit of individualism. They emphasized the artist's point of view (perspective) by creating the illusion of a third dimension on a two-dimensional surface. Copernicus changed the observer's perspective from the center to the periphery, believing that charting planetary orbits from an earth that revolved around the sun would produce a more accurate picture.

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Use of perspective in Renaissance art

Like a good Renaissance humanist scholar, Copernicus first sought validation for his theory in ancient sources. There, he "found in Cicero that Hicetas supposed the earth to move." He later "also discovered in Plutarch that certain others were of this opinion." With ancient sources to support him, Copernicus felt he could also assert "the mobility of the earth":

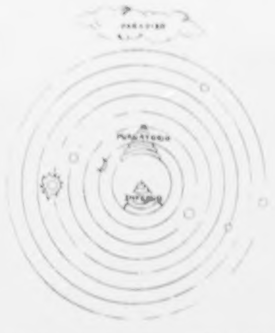
> *I knew that others before me had been granted the liberty of imagining whatever circles they wished to represent the phenomena of the stars, I thought that I likewise would readily be allowed to test whether, by assuming some motion of the Earth's, more dependable representations than theirs could be found for the revolutions of the heavenly spheres....I eventually found by long and intensive study that if the motions of the wandering stars are referred to the circular motion of the Earth and calculated according to the revolution of each star, not only do the phenomena agree with the result, but also it links together the arrangement of all the stars and spheres...and the very heavens, so that nothing can be moved in any part of it without upsetting other parts of the whole universe (Copernicus 26).*

In 1514, Copernicus privately circulated a short book, the *Commentariolus*, in which he set out the main ideas of his heliocentric system. It is believed that he completed all of the calculations necessary for a mathematically supported treatise by the 1520s. But it was not until 1543, when he was nearly 70, that Copernicus finally braced himself to publish such a text—*De Revolutionibus Orbium Coelestium* (*On the Revolutions of the Heavenly Spheres*). He supposedly saw a copy of his book only once—on his deathbed.

Medieval Cosmology

What made Copernicus so hesitant? It was because he was not merely challenging the observations of some ancient Greek astronomer. Copernicus was questioning the perceived natural order of the cosmos. The accepted cosmology of Copernicus' time was a blend of ancient Greek philosophy and medieval Christian theology. Aristotle (384–322 BC) maintained, for example, that the orbits of stars and planets were circular because ancient Greek philosophers saw the circle as the perfect geometric shape. He also divided the universe into a lower realm on earth and a higher realm above. Aristotle and his contemporaries believed that earthly objects were composed of four elements—earth, water, fire and air. They thought that celestial objects were composed of "divine ether," a substance too pure, clear, fine and spiritual to be found on earth. They therefore saw two sets of laws operating in the universe, one on earth and the other in the heavens.

These ideas were fused with medieval Christian concepts of perfection versus corruption, good versus evil, and salvation versus damnation. This cosmology did not merely describe the motions of stars and planets. It diagrammed the relationship between goodness and evil. It also explained why human beings sinned and how they could be saved. Copernicus' contemporaries were not likely to set aside this masterfully crafted explanation of the cosmos without good cause.



Medieval cosmology as depicted in Dante's *Divine Comedy*

Protestant Reformation

Another reason for Copernicus' hesitancy was the Protestant Reformation. The Reformation officially began in 1517, when Martin Luther (1483–1546) posted his objections to certain practices of the Catholic Church on the door of a German church. In time, Luther and the Protestants challenged the most fundamental doctrines of the Catholic Church. They asserted that the "good works" prescribed by the Catholic Church played no role in a person's salvation and insisted that the Church's priests were unnecessary intermediaries between the individual and God. They also denied the doctrine of Papal infallibility, claiming instead that ultimate truths were to be found in the Bible. In such a climate, the Catholic Church was not likely to welcome challenges to its affirmed view of the universe, especially from one of its own officials.

Attacks on Copernicus' Theory

For these reasons, Copernicus anticipated attacks against him and his astronomical theory. He therefore dedicated *De Revolutionibus* to Pope Paul III, with the hope that the Pope might protect him from vilification:

> *I can well appreciate, Holy Father, that as soon as certain people realise that in these books which I have written about the Revolutions of the spheres of the universe I attribute certain motions to the globe of the Earth, they will at once clamour for me to be hooted off the stage....Accordingly as I thought it over, the contempt which I had to fear because of the novelty...of my opinion had almost driven me to suspend completely the work which I had begun.*
>
> *But though I long hesitated and even resisted, my friends drove me back to it....[They] often urged me, and demanded of me...to issue this book, and at last allow it to come into the light of day, after I kept it suppressed and hidden...for almost four times nine years....I have no*

> *doubt that talented and learned astronomers will accept my arguments if they are willing not perfunctorily but thoroughly to examine and weigh the evidence for these matters which I bring forward in this work. Yet so that learned and unlearned may see that I am not avoiding judgment by anyone at all, I have preferred to dedicate these my labours to your Holiness rather than to anyone else because even in this far off corner of the Earth in which I live you are considered as distinguished by the authority of your office and by your love of all learning...so that by your influence and judgment you can restrain the stings of false accusers, although it is proverbial that there is no remedy against the sting of the sycophant.*
>
> *There may be triflers who though wholly ignorant of astronomy nevertheless abrogate the right to make judgments about it because of some passages in Scripture wrongly twisted to their purpose, and will dare to criticise and censure this undertaking of mine. I waste no time on them, and indeed I despise their judgment as thoughtless (Copernicus 23-26).*

As Copernicus had anticipated, his work was attacked. Attacks came from academics and theologians, both Catholic and Protestant. First, they pointed out that Copernicus' system contradicted passages in the Bible, which described a stationary earth and a sun in motion. Second, they argued that a massive body such as the earth could not be hurled through space at the kind of speed Copernicus proposed. Third, they asked if the earth spins on its axis, why objects drop straight down rather than some point behind where they were released. Fourth, they challenged Copernicus to explain why objects did not simply fly off a rapidly moving earth. Finally, they questioned how the moon could orbit the earth and the sun at the same time.

Copernicus was not around to respond to these criticisms. His direct supporters could not adequately answer them. Thus his theory was rejected by the Catholic Church and most of the academic community. Within a matter of decades, though, aspects of Copernicus' observations and mathematical techniques became indispensable to practicing astronomers. For example, German astronomer Johannes Kepler (1571–1630) used Copernicus' theories and the work of Danish astronomer Tycho Brahe (1546–1601) to create his "laws of planetary motion," which would shape modern astronomy. First, Kepler maintained that the orbits of planets around the sun were elliptical rather than circular. Second, he demonstrated that the planets' orbital speeds were not uniform. Third, he determined that the time each planet took to complete its orbit was precisely related to its distance from the sun.

Medieval Scholasticism Challenged by Bacon and Descartes

While Renaissance astronomers challenged medieval concepts of the universe, Renaissance philosophers such as Francis Bacon and René Descartes questioned medieval methods of acquiring knowledge. The dominant school of medieval learning was Scholasticism, which tried to reconcile classical philosophy with Christian faith. Scholastics relied on the authority of ancient and Christian texts to answer all questions. Their most important authority was Aristotle, whom they simply called "the Philosopher." Their major effort went into mastering past knowledge and organizing it logically. At their best, Scholastics created marvelous systems of logic, such as Thomas Aquinas' (1225–1274) *Summa Theologica* and the cosmological system described in Dante's *Divine Comedy*. At their worst, Scholastics produced endless debates over how many angels could dance on the head of a pin.

Bacon (1561–1626) was an influential figure in England's political and intellectual circles. He served, at one time, as his country's lord chancellor. Intellectually, Bacon despised Scholasticism. First, he disliked the way Scholasticism mixed religion and natural philosophy (science) "to the confusion of both." Religion, according to Bacon, was a pious expression of faith. Bacon believed that natural philosophy, or science, should be a quest to understand the natural order of the universe through "patient inquiry." As he saw it, natural philosophers did not have the capacity to teach people the meaning of virtue or how to get to Heaven. In the same way, theologians were not equipped to explain how plants grow or rivers behave. He therefore argued that religion and natural philosophy should be taught as two separate spheres of knowledge.

Second, Bacon criticized Scholasticism for neglecting empirical research (knowledge gained through the senses). He believed that scholars should examine actual trees and rocks rather than study only what Aristotle said about them. In his *Novum Organum* (*New Instrument*) and *New Atlantis*, Bacon called for the use of the "inductive method" of acquiring knowledge. This method relied on particular observations to arrive at generalizations. By studying particular trees, such as apple trees and peach trees, scholars could induce knowledge about trees in general. By conducting similar studies for seeds and flowers, scholars could acquire knowledge about plants in general. In this way, Bacon argued, scientific knowledge would be dynamic and cumulative. Scientific knowledge would be open to change—always testing, always revising, always letting new observations and experiments modify what is known. Scientists would not rely exclusively on past knowledge and would have confidence that people in the future would always know more than those who came before them.

Finally, Bacon disliked Scholasticism because it was "only strong for disputations and contentions, but barren of the production of works for the benefit of mankind." He felt that scientific knowledge should give human beings power, so that they would not be as helpless in the face of nature. Bacon suggested that instead of contemplating the essence of plants or how they relate to things divine, people should study plants in order to understand how they might yield larger harvests. In the same way, rivers should be studied in order to avoid floods and discover how their energy could be harnessed for human benefit. Bacon observed that "uneducated" people had been doing this for centuries. Farmers, for example, learned to fertilize their land and breed their livestock. Their knowledge, however, had been unmethodological, haphazard and hit-or-miss. Bacon felt that they could have acquired knowledge much faster if they had proceeded systematically—utilizing the inductive method. Bacon illustrated his view with his metaphor of the "three kinds of minds." The first was like the ant that piled up tons of data but saw nothing to make of it. The second was like the spider that wove exquisite and complex webs. But the webs contained only the stuff of its own being. The third, which Bacon preferred, was the honey bee that took things from nature and mixed it with the stuff of its own being to produce something sweet and useful to humankind.

Like Bacon, Descartes (1596–1650) came to doubt the validity of Scholasticism. Descartes' skepticism developed in the course of his education:

> *From my childhood I lived in a world of books [Aristotle and other sources of Scholastic authority], and since I was taught that by their help I could gain a clear and assured knowledge of everything useful in life, I was eager to learn from them. But as soon as I had finished the course of studies which usually admits one to the ranks of the learned, I changed my opinion completely. For I found myself saddled with so many doubts and errors that I seemed to have gained nothing in trying to educate myself unless it was to discover more and more fully how ignorant I was....*
>
> *This is why I gave up my studies entirely as soon as I reached the age when I was no longer under the control of my teachers. I resolved to seek no other knowledge than that which I might find within myself, or perhaps in the great book of nature (Descartes 5-8).*

Descartes decided to set aside all that he had learned and start over. He felt that it was necessary to begin by doubting everything. Yet, as he proceeded, the one thing Descartes could not doubt was his own existence:

> *But I soon noticed that while I thus wished to think everything false, it was necessarily true that I who thought so was something. Since this truth,* I think therefore I am, *was so firm and assured that all the most extravagant suppositions of the skeptics were unable to shake it, I judged that I could safely accept it as the first principle of the philosophy I was seeking (Descartes 24).*

From this starting point, Descartes built a system of learning which he outlined in his *Discourse on Method* (1637):

> *I thought that instead of the great number of precepts of which logic is composed, I would have enough with the four following ones, provided that I made a firm and unalterable resolution not to violate them even in a single instance.*
>
> *The first rule was never to accept anything as true unless I recognized it to be evidently such [preferably supported by mathematical proofs]: that is, carefully to avoid precipitation and prejudgment, and to include nothing in my conclusions unless it presented itself so clearly and distinctly to my mind that there was no reason to doubt it.*
>
> *The second was to divide each of the difficulties which I encountered into as many parts as possible, and as might be required for an easier solution [the process of analysis].*
>
> *The third was to think in an orderly fashion, beginning with the things which were simplest and easiest to understand, and gradually and by degrees reaching toward more complex knowledge, even treating, as though ordered, materials which were not necessarily so.*
>
> *The last was always to make enumerations so complete, and reviews so general, that I would be certain that nothing was omitted (15).*

Through this method, Descartes sought to establish general laws that could stand up to his rigorous logical and mathematical scrutiny. From these, he could deduce specific truths about the world around him.

While Bacon and Descartes made no scientific "discoveries," they helped to establish a system of acquiring knowledge that came to be called the scientific method. This method was built on Bacon's call for precise observations and experimentation. It also incorporated Descartes' search for general laws that could be expressed in rigorously logical and mathematical language.

A hypothetical depiction of Galileo conducting an experiment on the velocity of falling bodies from the leaning tower of Pisa (National Archives).

Galileo and the Scientific Method

The Renaissance astronomy of Copernicus and Kepler, as well as the Renaissance philosophy of Bacon and Descartes, became progressively more incompatible with the medieval way of conceptualizing and investigating the universe. The conflict came to a head with the career of Galileo Galilei (1564–1642), the brilliant Italian scientist and mathematician. At the age of 25, Galileo was appointed Professor of Mathematics at the University of Padua in the Republic of Venice. The pragmatic Venetians chose Galileo for his practical craftsmanship as well as for his mathematical skills. When Flemish eyeglass-makers invented a primitive spyglass in 1608, Galileo immediately tried to make one of his own. In time, Galileo successfully increased the magnification of his apparatus to the point that he had a real telescope. Galileo marketed his telescope as an indispensable tool for navigators and military officers. This brought him fame and fortune.

Galileo then transformed his telescope from a practical tool into an instrument of research by further increasing its magnification and turning it toward the heavens. In this way, he advanced the emerging scientific method, which relied on careful observations and controlled experiments. Galileo had earlier conducted experiments on the problem of motion. He probably did not drop cannonballs off the "leaning tower" of Pisa, but he did roll brass balls of different weights down inclined ramps to prove that the uniform force of gravity produced uniform acceleration with objects of different mass. With this and other experiments, Galileo formulated the law of inertia, which maintained that an object in motion continues forever unless it is acted on by some external force. His work would play a pivotal role in the study of motion and gravity.

The significance of Galileo's research method was that he did not begin with a preconception. Instead, he conducted careful observations and experiments *before* coming to any conclusions. Galileo employed this method when he studied the heavens with his telescope and published his findings in *Sidereus Nuncius* (*The Starry Messenger*). The book became an instant bestseller among Europe's elite. Galileo capitalized on its success by making and selling telescopes along with his books. In *The Starry Messenger*, Galileo described the moon as he saw it through his telescope.

These observations contradicted the medieval notion that celestial objects were composed of a "divine" substance not found on earth. The observations also challenged the medieval belief that nature existed in an ascending order of perfection (away from the earth and toward God's paradise):

> *[I]t is seen that the Moon is most evidently not at all of an even, smooth, and regular surface, as a great many people believe of it and of the other heavenly bodies, but on the contrary it is rough and unequal. In short it is shown to be...full of prominences and cavities similar, but much larger to the mountains and valleys spread over the Earth's surface (Starry Messenger 11).*

Then Galileo turned to the new starlets that he discovered near Jupiter:

> *[O]n the seventh day of January of the present year 1610, at the first hour of the night, when I inspected the celestial constellations through a spyglass, Jupiter presented himself. And since I had prepared for myself a superlative instrument, I saw (which earlier had not happened because of the weakness of the other instruments) that three little stars were positioned near him—small but yet very bright.*

His careful observations yielded Galileo another discovery. He found that on January 8, one day later, the positions of the three stars near Jupiter had changed.

> *I found that the observed change was not in Jupiter but in the said stars....I therefore arrived at the conclusion, entirely beyond doubt, that in the heavens there are three stars wandering around Jupiter like Venus and Mercury around the Sun. This was at length seen clear as day in many subsequent observations, and also that there are not only three, but four wandering stars making their revolutions about Jupiter (Starry Messenger 64-66).*

Galileo saw this as an answer for people who rejected Copernicus' system because they could not accept the proposition that the moon orbited both the earth and the sun:

> *We have...an excellent and splendid argument for taking away the scruples of those who, while tolerating with equanimity the revolution of the planets around the Sun in the Copernican system, are so disturbed by the attendance of one Moon around the Earth while the two together complete the annual orb around the Sun that they conclude that this constitution of the universe must be overthrown as impossible...but our vision offers us four stars wandering around Jupiter like the Moon around the Earth while all together with Jupiter traverse a great circle around the Sun in the space of 12 years (Starry Messenger 84-85).*

Galileo and Church Authorities

For Galileo, the results of his research were obvious. They showed that medieval cosmology based on Ptolemy's astronomy simply did not work. Copernicus had been correct. Galileo thought that everyone would agree with him once they saw the "truth" for themselves. He was wrong. For one thing, officials of the Catholic Church were not as concerned with who was correct as they were with who was to make that determination. For them, it was a question of authority. The Catholic Church's authority had been badly shaken by the Protestant Reformation, and they would not tolerate this Italian scientist's questioning of the Roman Church's interpretation of the cosmos. Galileo's views were attacked by clerics and academics.

Galileo was shocked and angered by these attacks. He lashed out at his critics in a 1615 letter to Grand Duchess Christina of Tuscany:

> *Some years ago, as Your Serene Highness well knows, I discovered in the heavens many things that had not been seen before our age. The novelty of these things, as well as some consequences which followed from them in contradiction to the physical notions commonly held among academic philosophers, stirred up against me no small number of professors—as if I had placed these things in the sky with my own hands in order to upset nature and overturn the sciences. They seemed to forget that the increase of known truths stimulates the investigation, establishment, and growth of the arts; not their diminution or destruction.*
>
> *Showing a greater fondness for their own opinions than for truth, they sought to deny and disprove the new things which, if they had cared to look for themselves, their own senses would have demonstrated to them....*
>
> *[T]hese men have resolved to fabricate a shield for*

> *their fallacies out of the mantle of pretended religion and the authority of the Bible. These they apply, with little judgment, to the refutation of arguments that they do not understand and have not even listened to....*
>
> *I do not feel obliged to believe that that same God who has endowed us with senses, reason, and intellect has intended to forgo their use and by some other means to give us knowledge which we can attain by them. He would not require us to deny sense and reason in physical matters which are set before our eyes and minds by direct experience or necessary demonstration.*

This passage demonstrates again Galileo's commitment to "sense and reason" in human attempts to understand the cosmos. Galileo thought that in addition to having sense and reason on his side, he had the intellect and reputation to persuade the Pope to reverse the position the Church took on the heliocentric system in 1616:

> *Propositions to be forbidden:*
> *that the sun is immovable at the centre of the heaven;*
> *that the earth is not at the centre of the heaven, and is not immovable,*
> *but moves by a double motion.*

Again, Galileo was wrong. He tried to assure Pope Urban VIII that God was not "any less excellently revealed in Nature's actions than in the sacred statements of the Bible." Urban VIII believed, however, that human beings were not capable of finding an ultimate test of God's design. "It would be," he stated, "an extravagant boldness for anyone to go about to limit and confine the Divine power and wisdom to some one particular conjecture of his own." In other words, Urban VIII would not have Galileo confining God's power within a prescribed set of natural laws, thereby preventing Him from running the universe through miracles.

Galileo misconceived the concerns of Urban VIII, the spiritual head of the Catholic Church and the secular ruler of the Papal States. This led Galileo to publish *Dialogue Concerning the Two Chief World Systems* (1632). This book did not overtly advocate the heliocentric system. But it did directly challenge the traditional and officially sanctioned methods of conceptualizing and investigating the universe. In *Dialogue*, Salviati, the spokesman for Galileo's views, chastises Simplicio and other Scholastics for mindlessly relying on "authorities":

> *SIMPLICIO: But in case we should give up Aristotle, who is to be our guide in philosophy? Name you some author.*
> *SALVIATI: We need a guide in unknown and uncouth lands, but in clear thoroughfares, and in open plains, only the blind stand in need of a leader; and, for such, it is better that they stay home. But he who has eyes in his head and in his mind has to use these for his guide. Yet mistake me not, thinking that I speak this because I am against hearing Aristotle; for, on the contrary, I commend the reading and diligent study of him and only blame servilely giving one's self up a slave to him, so as blindly to subscribe to whatever he delivers, and receive it for an inviolable decree without search of any further reason. (Dialogue 125-126)*

The Pope was outraged. Galileo was brought before the Inquisition in 1633. Though he attempted to defend his right to publish his *Dialogue*, he was found guilty of heresy. He was placed under house arrest for the rest of his life and was prohibited from communicating with other scientists and scholars. Furthermore, he was ordered to publicly retract his views. In order to make sure that he complied, Galileo was brought in to see the Inquisition's instruments of torture. This was enough for the elderly scientist. He made the following statement:

> *I, Galileo Galilei...seventy years of age, arraigned personally before this tribunal, and kneeling before you, Most Eminent and Most Reverend Cardinals Inquisitors-General against heretical depravity in all of Christendom, having before my eyes and touching with my hands the Holy Gospels, swear that I...abandon completely the false opinion that the sun is the center of the world and does not move, and that the earth is not the center of the world, and moves, and that I must not hold, defend, or teach this false doctrine in any way whatsoever... (Finocchiaro 292).*

Galileo's trial and conviction brought a chill over Europe's scientific community. It ended the Mediterranean scientific tradition that stretched back to Pythagoras and Archimedes in ancient Greece. Scientists and philosophers living in Catholic countries either stopped writing or moved to Protestant countries in northern Europe. Descartes stopped publishing in France and then went to live in Sweden. Galileo died in 1642, still a prisoner in his house. Kepler had died twelve years earlier. The Scientific Revolution, it seemed, had come to a dead end.

Newton's Synthesis

On Christmas Day 1642, Isaac Newton was born in the small English town of Woolsthorpe. In the course of his productive life, Newton (1642–1727) would produce causal explanations for the careful descriptive astronomy of Copernicus, Kepler and Galileo. He would also synthesize the empirical, experimental and inductive method championed by Bacon with the rational, mathematical and deductive system developed by Descartes.

Newton was secretive, petty and vindictive. He was also a genius. This meant that all of his brilliant achievements were conceived alone. He worked intensively on problems being debated within Europe's scientific community. One problem concerned planetary orbits. Relying on their own observations, astronomers such as Copernicus, Galileo and Kepler determined that the natural (inertial) motion of planets was circular or elliptical. Descartes disagreed. Basing his theory purely on logic, he insisted that the natural motion was a straight line. Newton began tackling this problem with the assumption that planetary orbits were elliptical (as Kepler had maintained). This meant that he could not make his calculations with Euclidean geometry, which provided formulas for only "regular' shapes, such as circles, squares and triangles. He therefore developed "fluxions" or calculus—a major breakthrough in the history of mathematics. Newton did not want to share his invention with anyone else. So he made his discoveries with fluxions but wrote them out in the conventional mathematics of his time.

Newton used fluxions to calculate the force of attraction (gravity) that kept the moon in orbit around the earth:

> *[F]rom Kepler's Rule of the periodical times of the Planets being in...proportion of their distances from the centers of their Orbs, I deduced that the forces which keep the planets in their Orbs must be reciprocally as the squares of their distances from the centres about which they revolve: and thereby compared the force requisite to keep the Moon in her Orb with the force of gravity at the surface of the earth; and found them answer pretty nearly (Marks 67).*

His first rough calculation set the moon's orbit time at 27.25 days—just about the exact time. Newton had uncovered a law of nature that was both universal and susceptible to mathematical calculations. This discovery would fundamentally alter the way human beings viewed themselves and the universe in which they lived. But it was Newton that made this discovery. He did not publish his findings. Thus it would remain hidden for almost 20 years.

In 1684, an argument over planetary orbits erupted between the renowned scientist Robert Hooke, the gifted architect Christopher Wren and the young astronomer Edmund Halley. Halley was sent by the other two to discuss the problem with Newton:

> *Without mentioning either his own speculations, or those of Hooke and Wren, Halley at once indicated the object of his visit by asking Newton what would be the curve described by the planets on the supposition that gravity diminished as the square of the distance. Newton immediately answered,* an Ellipse. *Struck with joy and amazement, Halley asked him how he knew it? Why, replied he, I have calculated it; and being asked for the calculation, he could not find it, but promised to send it to him (Marks 71).*

Halley thought it would take Newton a few days to produce the calculations. It took him three years. Halley had to coax, beg and humor Newton from start to finish. He wound up financing the publication of Newton's findings—in *Principia Mathematica* (1687).

Principia was a path-breaking work which described a universe subsumed under a single set of laws. These fundamental, cosmic laws applied to all matter, from the minutest object to the universe as a whole. This was clearly presented in Newton's definition of his "laws of motion":

> AXIOMS, OR LAWS OF MOTION
>
> LAW I
>
> Every body continues in its state of rest, or of uniform motion in a right [straight] line, unless it is compelled to change that state by forces [such as gravity] impressed upon it.
>
> LAW II
>
> The change of motion is proportional to the motive force impressed; and is made in the direction of the right line in which that force is impressed.
>
> LAW III
>
> To every action there is always opposed an equal reaction: or, the mutual actions of two bodies upon each other are always equal, and directed to contrary parts (Newton 13).

With his work, Newton made the natural world seem knowable to those who employed the scientific method of observation, experimentation and calculation. For these scientists, nature came to resemble a gigantic machine that operated under a few, simple and uniform set of laws. At once, they applied Newton's laws to predict the ebb and flow of the earth's tides. In 1846, astronomers used Newton's laws to deduce the presence of the planet Neptune from Uranus' orbital irregularities. Several decades later the existence of Neptune was visually confirmed by high-powered telescopes.

While many of his concepts have been superseded by 20th century physics, Newton's influence has remained strong. This was because his work combined Bacon's inductive experimentalism with Descartes' deductive, mathematical rationalism to round out the modern scientific method. Newton also embodied Bacon's notion that scientific knowledge is progressive and cumulative. In a rare moment of humility, he wrote, "If I have seen further [than others], it is by standing on the shoulders of Giants [such as Copernicus, Kepler and Galileo]."

The Scientific Revolution and Europe's Intellectual Revolution

The impact of the Scientific Revolution has been profound. Its most direct influence was on European intellectuals who created a movement that they called the Enlightenment. These intellectuals saw that most human beings lived in ignorance and superstition. They believed that people could emerge from this darkness (into sunlight) if they used their minds properly. Their inspiration was Isaac Newton. "Nature and nature's laws lay hid in night," wrote the poet Alexander Pope, then "God said let Newton be! And all was light."

Enlightenment intellectuals greatly admired the accomplishments of the Scientific Revolution. Their favorite term, *reason*, literally meant the use of the scientific method to understand everything. Newton's *Principia*, however, was not an easy read. Early Enlightenment writers therefore set out to make difficult scientific concepts accessible to a broad nonscientific audience. The French writer Bernard de Fontenelle (1657–1757), for example, tried to make his works on science read like novels. His *Conversations on the Plurality of Worlds* (1686) begins with an elegant couple strolling through a park. They sit and gaze at the stars. They then engage in a passionate discussion of recent developments in astronomy. In such ways, heliocentric ideas and the universal law of gravitation entered the European world view. Today, science fiction literature, films and television programs, including the *Star Trek* series, make concepts such as relativity and quantum physics accessible to lay audiences.

Enlightenment writers also brought science into sharp conflict with religion. Copernicus, Galileo and Newton were devout Christians. They argued passionately, although not always successfully, that their scientific findings exalted rather than diminished God. Many Enlightenment thinkers, on the other hand, saw science as refuting the dogmatic doctrines of organized religions. For example, Francois Marie Arouet, better known by his pen name Voltaire (1694–1778), was so angered by the dogmatism and fanaticism of organized religions that he cried out, "Crush the infamous thing!"

Moral and Ethical Challenges for Science

The combination of scientific achievements and intellectual attacks on religion produced a shift in the way people viewed themselves and the world in which they lived. Science became the dominant voice in describing the universe and how it should be investigated. Historian Franklin le van Baumer described the triumph of science over religion in his article "The Scientific Revolution in the West":

> *Science made the world of the spirit... seem unreliable and dim by comparison with the material world. In the seventeenth century, science drove revealed Christianity out of the physical universe into the region of history and private morals; to an ever growing number of people in the two succeeding centuries it made religion seem outmoded even there....It changed profoundly man's attitude toward custom and tradition, enabling him to declare his independence of the past, to look down condescendingly upon the "ancients," and to envisage a rosy future (Reilly 82-83).*

Science has triumphed. But would the pioneers of the Scientific Revolution celebrate the way that it has triumphed? Today, most people accept scientific explanations as articles of faith rather than theories to be tested. If people are asked why we do not simply fly off a rapidly moving earth, they would reply "gravity, of course." How many of them, however, would have conducted the simplest observations or experiments before reaching that conclusion? Galileo argued as passionately for the method of his investigation as he did for the conclusions he derived from them. He pleaded with his critics to "come and see" for themselves what he had observed through his telescopes. Would Galileo be comforted by the fact that the Old and New Testaments have been replaced by the gospels according to Newton and Darwin?

Furthermore, would the pioneers of the Scientific Revolution approve of banishing religion to the realm of "history and private morals" and then exiling it from even those areas? Religious wars, inquisitions and witch burnings confirm that organized religions have not always performed well on moral and ethical issues. But are scientists better equipped to deal with them? Scientists can create weapons of mass destruction. But they are hesitant to advise policy-makers on when and how to use them. Here, Albert Einstein was a rare exception. In 1939, he became concerned that his theories on matter and energy would lead to the creation of a nuclear weapon, which Nazi Germany might develop first. Einstein therefore wrote a letter to President Franklin D. Roosevelt, warning him of this development:

> *In the course of the last four months it has been made probable—through the work of Joliot in France as well as Fermi and Szilard in America—that it may become possible to set up a nuclear chain reaction in a large mass of uranium, by which vast amounts of power and large quantities of new radium-like elements would be generated. Now it appears almost certain that this could be achieved in the immediate future.*
>
> *This new phenomenon would also lead to the construction of bombs, and it is conceivable...that extremely powerful bombs of a new type may thus be constructed. A single bomb of this type, carried by boat and exploded in a port, might very well destroy the whole port together with some of the surrounding territory....*
>
> *In view of this situation you may think it desirable to have some permanent contact be maintained between the Administration and the group of physicists working on chain reaction in America (Hoffmann 205-206).*

The letter led to the creation of the Manhattan Project, which produced the atom bomb. After atomic bombs were dropped on Hiroshima and Nagasaki, Einstein carried the guilt of having contributed to the deaths of the cities' inhabitants—all the way to his grave. As noted earlier, Einstein's response was exceptional. More typical was Newton's reply to those who asked about the implications of his discoveries. He simply told them "I make no hypotheses."

Are scientists responsible for their discoveries and inventions? Mary Shelly (1797–1851) asked this question in her novel *Frankenstein*. Having created life, was Victor Frankenstein responsible for his creature's welfare? Was he responsible for the destruction that it caused? Today, as cloning shifts from science fiction to scientific reality, such questions become very relevant. Also, as genetic research uncovers causes for catastrophic illnesses, such as Lou Gehrig's disease, the moral and ethical limits of genetic engineering may be tested. Future parents might not have to worry about their children being born with genetic time bombs. But if and when it becomes possible to eliminate shortness, fatness, baldness and other "undesirable" features, who will decide what types of genetic engineering are to be permitted? This will become more complicated if it becomes possible to alter skin color, physical strength or intelligence. The *Star Trek* television series predicted a "eugenics war" would erupt over future genetic policies. The prediction, of course, is based on history—the eugenics policies of Nazi Germany in the 1930s and 1940s.

The march of science in the last three centuries has been rapid and relentless. It has given human beings the power, as Bacon had hoped, to control and manipulate nature. But at what price was this achieved? Human "progress" has caused the extinction of numerous species and threatened our own ecological welfare. Human beings are not likely to give up the fruits of science and technology, such as electrical power or vaccines. Nor should we. But at the end of the 20th century, we have come to realize that human morals and ethics have not kept pace with scientific developments. Like Shelly's young scientist, we have gained fantastic powers but often lack the maturity to use them properly.

AREAS OF STUDY ABOUT THE IMPACT OF THE SCIENTIFIC REVOLUTION

Birth of the Social Sciences and Challenges to Traditional Political Authority

The Scientific Revolution also helped give birth to the social sciences. Enlightenment intellectuals believed that Newton's scientific method could be used to discover natural laws underlying all aspects of human behavior. Those studying the "science of man" often referred to themselves as "Newtons of the mind." French Physiocrats, for example, believed they had discovered natural laws that governed all economic behaviors. Their most prominent "law" was that of supply and demand. These early economists believed that societies would most benefit from allowing individuals to pursue their "natural" economic self-interests. Their *laissez-faire* doctrine therefore advised against government intervention in the economic affairs of their nations. This view was most clearly expressed by the Scottish philosopher Adam Smith (1723–1790) in his treatise *An Inquiry into the Nature and Causes of the Wealth of Nations* (1776).

The study of politics was also influenced by scientific notions of natural law. Early political scientists, such as John Locke (1632–1704), provided naturalistic explanations for the existence of governments. These ideas challenged the concept of the "divine right of kings" as expressed by Cardinal Richelieu of France (1585–1642) and King James I of England (1567–1625). Richelieu's *raison d'etat* (reason of state) maintained that "what is done for the state is done for God, who is the basis and foundation of it."

Casting aside metaphysical explanations, Locke argued that governments developed "naturally" from the needs of individuals. In his *Two Treatises of Civil Government* (1690), Locke stated that human beings originally lived in a "state of nature," where no laws existed and everyone had absolute freedom. In time, individuals realized that the dangers and inconveniences of living in the anarchic state of nature greatly outweighed its advantages. They therefore formed civil societies and surrendered some of their freedoms to them. Locke maintained, however, that the authority of the civil government could not exceed the powers its citizens agreed to surrender to it: "Men being...by nature all free, equal, and independent," he wrote, "no one can be put out of this estate and subjected to the political power of another without his own consent" (Riley, 57). Locke's ideas became the cornerstone of the modern theory of *constitutionalism*, which views government as limited and in a contractual relationship with its citizens.

Many of the "laws" of human behavior established by early social scientists proved to be less than universal in the long run. However, their work toward a scientific understanding of human behavior has persisted. It has thrived in the 20th century, playing significant roles in people's lives through the disciplines of psychology, sociology, economics, anthropology and political science.

Technological and Industrial Revolutions

Medieval Scholasticism drew a sharp distinction between the *liberal* and the *servile* arts. Those engaged in the liberal arts worked exclusively with their minds, such as poets, logicians and mathematicians. Those involved with the servile arts worked with their hands and minds (to change matter), such as carpenters, ironworkers and sculptors. Renaissance scientists disrupted this distinction. By creating a marriage between the liberal arts and the servile arts, they laid the groundwork for scientists and technicians to work together to create the industrial revolution.

For example, in the field of medicine in medieval Europe, there was a distinction between physicians, whose diagnoses were considered liberal, and surgeons, whose operations were seen as servile. Preferring the liberal over the servile, medieval universities looked down on medical experiments as well as experiments in general. Vivisections were deemed repulsive and illegal. William Harvey (1578–1657) made his discoveries on the human circulatory system by rejecting the academy's scorn for manual work. He cut the veins and arteries of living animals to observe and record the flow of blood and the motions of the heart. Harvey risked his career each time he performed experiments that seem sensible and obvious today. By doing so, he facilitated the marriage of the liberal and servile arts that produced revolutions in technology and industry.

The marriage of the two arts led to the growth of mathematically trained craftsmen, who would make compasses, maps and other navigational instruments for Europe's overseas exploration and trade. In the development of the industrial revolution, it was a maker of scientific instruments, James Watt, who perfected the steam engine, which would make industry run. It was a Cornish blacksmith, Richard Trevithnick, who used steam power to build the first successful railroad locomotive. These developments were a reflection of the realization of Francis Bacon's dream: that science would become dynamic, cumulative and beneficial to humankind. Even though only a few (intellectually elite) Europeans participated in the Scientific Revolution, the long-term impact on people around the world would be enormous.

Global Impact of the Scientific Revolution

The combination of the scientific, technological and industrial revolutions profoundly affected the way Europeans thought and lived. These revolutions also gave Europeans the means to dominate the world. By the end of the 19th century, Western powers had colonized most of the earth's surface. Many non-Europeans were therefore introduced to Western civilization at the end of a gun barrel. Non-Europeans did not respect every aspect of Western culture, but many of their intellectuals recognized the value of Western science. The Indian intellectual leader Ram Mohan Roy (1772–1833), for example, promoted Western science and rational thought. At the same time, he extolled the superiority of Hinduism over Christianity.

The vast empires of Western powers, such as Great Britain and France, have crumbled in the 20th century. While its physical presence has diminished, the West's influence on world history has remained strong in certain areas. One of these is the scientific way of conceptualizing and investigating the universe. This may be the one aspect of the West's legacy that will live well into the next millennium.

Note: For additional bibliographic references related to the Scientific Revolution, see the section of the general bibliography on Science and Its Global Impact From the Renaissance Onward.

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MEDICINE, HEALING, AND THE BODY

by Jodi Vandenberg-Daves, National History Day

LESSON OBJECTIVES

The sections from the texts that follow are too short to allow students to compare and contrast what various cultures knew. Rather, taken together, these excerpts are meant to offer students the opportunity to explore how ancient healers approached illness and health, and what observations they made about the human body in sickness and in health. In the enrichment and extension section, students are asked to consider the long-term significance of developments in ancient medicine.

PREPARATION

The activities outlined here would be enriched by having students read selections of their world history textbooks on the cultures of ancient India, China and Greece. Discussion of current issues in medicine would also help students develop a context for interpreting these sources. A brainstorming session on debates in modern medicine might include discussion of so-called "alternative medicine," the growing interest of the American Medical Association in social problems, concerns about over-prescription of antibiotics, renewed public interest in the role of diet in health maintenance, and the role of physicians in modern society.

ACTIVITIES

You may use the following questions to stimulate discussion:

1. What causes of disease were observed in these ancient texts?
2. What about a person did a physician or other healer need to know to make a diagnosis? Make a list of the qualities of a sick patient in each of the three cases outlined (keeping in mind that some texts talk about specific problems, while others talk about illness generally). Discuss how the healer might have measured or observed these things and what the healer would have needed to know about the particular person and about health and disease generally.
3. How do these symptoms or conditions compare to the kinds of information today's physicians collect about a patient? What kinds of symptoms and context did ancient healers consider that modern ones do not? And vice versa? (Students might look up common symptoms of illness in a modern medical guide and compare and contrast them to the descriptions made by ancient healers.)
4. In each of these texts, how is good health defined? What did a person need to do to maintain good health? You might discuss similarities and differences to present-day advice for healthy living.
5. What role did the healer play in helping the patient get or stay well? Are there any clues to the role of the healer in these societies? Can any comparisons be made to the role of physicians in today's society?
6. Which, if any, of the observations made here qualify as scientific observations? How do we evaluate the role of science in the distant past, before the scientific revolution? Should we assume that only those medical observations that were later borne out by modern science were based on true "medical science"? Or should we assume that people who used the "scientific method" were practicing true medical science, even if the results were later found to be inaccurate? Is there a definition for "science" that works for all times and places?

ENRICHMENT AND EXTENSION

1. Students might develop projects that explore the significance of ancient medical knowledge to medical practice today. For example, some surgical tools are similar to those used today; the ancient Chinese practice of acupuncture is now being used throughout the world; and the Hippocratic oath is still used in medical training in Western cultures.
2. Recent discoveries have brought to light non-Western cultures' advanced knowledge in the fields of science and medicine. An important example is Chinese medicine. European scientist William Harvey is often credited with discovering the circulation of blood in the body in 1628. In fact, the Chinese were aware of the blood's circulation and the heart's role in circulating the blood by the second century BC! Scholars have found convincing evidence from that same time period that the Chinese knew how to isolate certain hormones from human urine and use them effectively for medicinal purposes; and they knew about the circadian rhythms of the human body, a concept that was not fully accepted in the West until late in the current century. Ask students to investigate why such discoveries were not made known throughout the world. Why do people today still believe that most advanced knowledge in medicine and other scientific and technical fields originated in the Western world? Have students find other examples of scientific and technological achievements from non-Western cultures.
3. Students might examine folklore studies to explore the everyday medical practices of various cultures of the late 19th century and early 20th century, a time when people were beginning to collect information on those practices but before medical practice was as standardized as it is today. For example, students might explore the practices and knowledge of "granny midwives" of the American South, Italian immigrants to the U.S., or the relatively isolated African-American population of the Carolina Sea Islands.

MEDICAL THEORIES AND PRACTICES OF ANCIENT CULTURES

The following excerpts from famous medical texts of three ancient cultures—India, China and Greece—offer a glimpse of how ancient physicians and other healers understood human health, the process of disease, medical treatment and human anatomy.

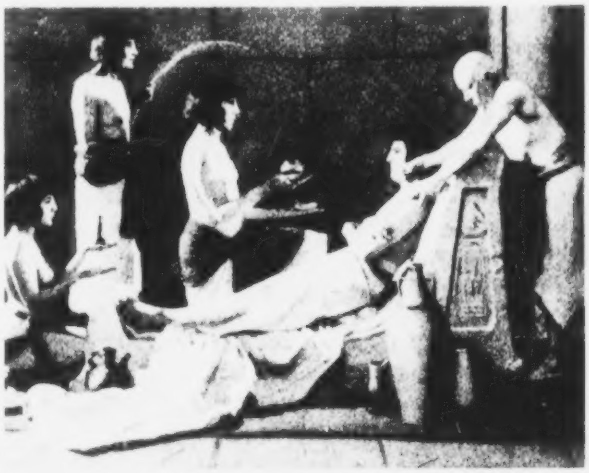
In ancient cultures, religion, philosophy and sometimes magic figured heavily into the healers' understanding of health, disease and healing. As scholars of medicine have pointed out: "All healing systems began in religion and philosophy and espoused mystical union with God or nature....In all cultures, the original healers were shamans or priests....In ancient Greece, the sick crowded the temple and the priests diagnosed them, often through the interpretation of dreams after hallucinogenic drugs."[1] The use of spells, incantations and ritual were commonplace in medical practice all over the world until well into the 20th century.

Science as we know it today is based on observation of the physical world and can in theory be completely unconnected to religious commitments; philosophy does not need to be invoked to explain scientific principles. In the ancient world of China, India and Europe, such was not the case. Yet ancient cultures also based their approaches to healing on careful observation of the patient (and, as you will see, his or her surroundings). And these cultures evolved approaches to medicine based on experiences passed down through generations and sometimes shared across cultures. For example, ancient Greek medicine was strongly influenced by the medical knowledge of the ancient Egyptians.

Each of the excerpts below are from classic texts of a particular culture, written records of both the healers (sometimes set apart as "physicians" and sometimes not) and of the practices of everyday people dealing with common and uncommon diseases, injuries, and attempts to preserve health. Throughout the world, people used the plants, roots, animals and foods around them to create medicines for specific ailments. They developed knowledge of human anatomy in various ways, such as through surgery and through observations of animal anatomy. In the case of the ancient Egyptians, the practice of embalming the dead gave people an unusually clear look at the details of the human body.

Sometimes symbolic rituals used by healers could develop into effective medical practices. For example, ancient Indians symbolically poured water through a reed to encourage a patient to urinate. Out of this practice the use of a catheter evolved. According to Cromwell Crawford, scholar of Hinduism, "Similarly, the early practice of symbolically applying a burning torch to a snake bite, to purify the demon, developed into a method of cauterization."[2]

The full versions of these ancient medical texts contained prescriptions for herbal remedies, instructions for the dressing of wounds and the setting of broken bones, observations on the development of the human fetus, nutritional advice, instructions for childbirth, instructions for surgery, and observations on the anatomy of humans and animals. Often, they also contained commentary on medical ethics as well as extensive philosophical discussions of the relationship of a person's physical health to other factors that modern science usually does not consider, such as the balance between "yin and yang" in the Chinese case, or the spiritual fortitude of the healer in the Greek case.



Surgeons of ancient Egypt had advanced knowledge of anatomy and wound treatment (Courtesy National Library of Medicine).

There were remarkable similarities among ancient cultures in their medical theories and practices. The notion of "wind" causing disease was prevalent in ancient India, Greece and China, and so was the emphasis on the importance of diet in the maintenance of health. Healers in all three cultures were interested in the interaction and balance of bodily fluids, such as "phlegm," "bile" and "blood," in the maintenance of health, the course of human development, and the causes of disease. Ancient Egypt and Mesopo-tamia shared much with the three cultures highlighted here. Some similarities can be accounted for by exchange of information, and some were probably the result of independent observation.

Medicine in Ancient India

The classical system of Indian medicine is known as *Ayurveda*. According to scholars of medicine, "traditional Indian medicine is alive and well today, unlike other ancient systems of medicine such as those of Babylon, Egypt, Persia, Greece, and Rome (with the exception of China)."[3] Much of ancient Indian medical knowledge has stood the test of time. Ancient practices, still widely used in India, are complemented by modern medical practices. Some surgical instruments from ancient India, such as bone forceps, are remarkably similar to those used in modern medicine to this day.

The *Caraka Samhita*, the key text of Ayurvedic medicine, was said to have been divinely inspired, having been passed to humans from the Hindu god Brahma. Scholars cannot say with certainty when the text was written, but they estimate that it dates from between 300

AD and 200 BC. Like most ancient texts of its kind, the *Caraka Samhita* codified, or put down on paper, practices that had probably been going on for centuries. According to scholar Jurgen Thorwald, the knowledge of the body and disease revealed in this text demonstrate the close observations physicians and other healers must have made. For example, "The *Caraka Samhita* discusses at least fourteen different abdominal tumors, twelve types of worm infections, sixty-five mouth infections, and thirty-one maladies of the nose."[3] The text also mentions 500 herbal drugs and contains evidence that the Indians knew of the symptoms of modern diseases such as diabetes.[4]

The sister text to the *Caraka Samhita* was the *Susutra Samhita*. It reveals ancient Indians' remarkable competencies in surgery. The Indians developed unique suturing techniques, performed experimental surgery unparalleled in the rest of the ancient world, and developed the world's first surgical treatment for cataracts.

Excerpt from* Caraka Samhita, *edited and published in 6 volumes with translations in Hindi, Gujarati and English. Jamnagar, India: Shree Gulabkunverba Ayurvedic Society, 1949, Chapter 18, 46-52; Chapter 21, 2-33.

Therefore treatment should be initiated after diagnosing the nature of the disease, the different regions of localization, and the special causative factors.

The physician who, after ascertaining all these three things, begins treatment intelligently and systematically will not err in therapeutic procedure.

Vata [wind], *pitta* [bile] and *kapha* [phlegm], reside either in their normal or pathological state in the bodies of all embodied creatures. Hence the learned physician should desire to recognise them.

Actions of the normal *vata* are animation, inspiration and expiration [respiratory movement], body-movement, regular circulation of body elements and regular elimination of excretions.

Actions of the normal *pitta* are the power of vision, digestive fire, body heat, hunger, thirst, softness of body, lustre, clearness of mind and intelligence.

Action of the normal *kapha* are viscousness, cohesion, firmness, heaviness, potency, strength, forgiveness, fortitude, and greedlessness.

Now the signs of decrease of *vata*, *pitta* and *kapha* are described to be decreased of their respective actions. There may be the loss of their normal functions or even the increase of contrary ones.

[The text goes on to describe disorders of *vata*, *pitta* and *kapha*]

In respect of their bodily conditions eight persons become censured.

They are—The very tall and the very short, the very hairy and the hairless, the very dark and the very fair, the very corpulent and the very emaciated.

Of these again the very corpulent and the very emaciated suffer from specially censurable traits....

Now we shall say what requires to be said concerning the very emaciated.

Indulgence in dry food and drink, starvation, under-eating, overwork, grief, suppression of the urges of nature and of sleep, dry massage, repeated baths, constitutional tendency, old age, the sequela of disease, and wrathful disposition render a man extremely emaciated.

The emaciated man cannot stand the strain of exercise or of a full-meal of hunger and of thirst, or of disease, or of strong medication. Similarly, he cannot bear great cold or heat....

That man is said to be over-emaciated who is lean of buttocks, belly, and neck, who is covered with a network of prominent vessels, who is reduced to skin and bones and who has prominent joints.

These two, the very corpulent and the very emaciated, are perpetually afflicted with diseases and are to be treated with constant slimming and nourishing remedies respectively.

Of the two conditions, emaciation is the lesser evil, though both alike require to be remedied. When both are overcome by disease it is the corpulent that suffers more.

The man who is well proportioned in flesh, well-knit in figure, and firm of sense is not overpowered by the violence of disease.

He that is able to endure hunger and thirst, heat and cold, and the strain of exercise, and has normal digestive and assimilative powers, is regarded as being properly proportioned in flesh.

For reducing the corpulent, heavy but non-nourishing food should be given; while for building up the emaciated, light but nourishing food should be given....

Sleep, cheerfulness, soft beds, peace and tranquility of mind; freedom from worry.... exercise; pleasant sights, fresh foods and fresh wines; juices of domestic, wetland and aquatic creatures and well prepared meats, curds, ghee and milks, the various kinds of sugarcane, sali rice, black-gram, wheat...oil-massage; bath and the use of the sandal-paste and flower-garlands; wearing of white raiment...these can cure even the extreme conditions of emaciation and confer the measure of plumpness on men.

Medicine in Ancient China

The classic text excerpted here, *The Yellow Emperor's Classic of Medicine* or *Nei Ching*, probably dates between 200 and 600 BC. Ch'i Po, the prime minister of Huang Ti (the "Yellow Emperor"), has been likened to the ancient Greek physician Hippocrates. According to medical scholar Donald Pachuta, "Both incorporated religion and philosophy, turned to nature, and created systems that lasted millennia. Both emphasized that perception is the fundamental tool of the physician. Both spoke of the internal and external causative factors of disease. They agreed that the internal factor, the spirit, is overwhelmingly important in both patient and practitioner."[5]

Chinese medicine developed significant anatomical knowledge far in advance of Europeans. In the second century BC the Chinese knew about the circadian rhythms of the human body and practiced the isolation of human hormones for medical purposes. They knew about the circulation of the blood through the body some 1800 years before scientists discovered it in Europe. Their knowledge was based in part on their careful analysis of a variety of patient symptoms. According to China scholar Robert Temple, "The Chinese traditionally identified twenty-eight different types of pulse, which they recognized as emanating from the pumping heart."[6] They also "carried out investigations in which they removed the blood vessels from corpses, stretched them to their full length, and made measurements of the total distance traveled by the blood in one circuit."[7]

The *Nei Ching* took the form of a conversation between Ch'i Po

Pharmacy in ancient China (Courtesy Park, Davis & Company).

and the emperor. The text is more philosophical than practical, except for its detailed description of the ancient Chinese practice of acupuncture. A passage on acupuncture highlights the Chinese emphasis on the role of the human mind in healing:

> *The Emperor asked: "When the body is worn out and the blood is exhausted, is it still possible to achieve good results?"*
>
> *Ch'i Po replied: "No, because there is no more energy left."*
>
> *The Emperor inquired: "What does it mean, there is no more energy left?"*
>
> *Ch'i Po answered: "This is the way of acupuncture: if man's vitality and energy do not propel his own will, his disease cannot be cured."*[9]

Another passage illustrates the emphasis on preventive medicine:

> *The superior physician helps before the early budding of the disease....The inferior physician begins to help when [the disease] has already developed; he helps when destruction has already set in....Hence, the sages did not treat those who were already ill; they instructed those who were not yet ill. They did not want to rule those who were already rebellious; they guided those who were not yet rebellious.*[10]

This quotation also shows how medical theory was linked to social philosophy; body and disease are compared to rulers and ruled. Similarly, the concepts of yin and yang were philosophical ideas that formed the basis for Chinese medical theory, with yin representing the female, darkness, moisture, cold and passivity, and yang representing the male, light, dryness, heat and activity. In Chinese cosmology, medicine and philosophy, yin and yang complemented and balanced each other, maintaining the social structure as well as the health of the human body.

Today, in a world of shared knowledge, Chinese medical knowledge, from pharmacology to acupuncture, is being revived and integrated into Western medicine, creating a new and interesting mix of science and philosophy.

"The Interaction of Yin and Yang," excerpted from* The Yellow Emperor's Classic of Medicine, *translated by Mark Coyle (Patricia Ebrey, ed.* Chinese Civilization and Society: A Sourcebook, *New York: The Free Press, 1981, 36-37).

The Yellow Emperor said: "The principle of Yin and Yang is the foundation of the entire universe. It underlies everything in creation. In order to treat and cure diseases one must search for their origins.

"Heaven was created by the concentration of Yang, the force of light; Earth was created by the concentration of Yin, the force of darkness....

"If Yang is overly powerful, then Yin may be too weak. If Yin is particularly strong, then Yang is apt to be defective. If the male force is overwhelming, then there will be excessive heat. If the female force is overwhelming, then there will be excessive cold. Exposure to repeated and severe heat will induce chills. Cold injures the body while heat injures the spirit. When the spirit is hurt, severe pain will ensue. When the body is hurt, there will be swelling. Thus, when severe pain occurs first and swelling comes on later, one may infer that a disharmony in the spirit had done harm to the body. Likewise, when swelling appears first and severe pain is felt late on, one can say that a dysfunction in the body has injured the spirit....

"Nature has four seasons and five elements. To grant long life, these seasons and elements must store up the power of creation in cold, heat, dryness, moisture, and wind. Man has five viscera in which these five climates are transformed into joy, anger, sympathy, grief, and fear. The emotions of joy and anger are injurious to the spirit just as cold and heat are injurious to the body. Violent anger depletes Yin; violent joy depletes Yang. When rebellious emotions rise to Heaven, the pulse expires and leaves the body. When joy and anger are without moderation, then cold and heat exceed all measure, and life is no longer secure. Yin and Yang should be respected to an equal extent...."

The Yellow Emperor asked, "Is there any alternative to the law of Yin and Yang?"

Ch'i Po answered: "When Yang is the stronger, the body is hot, the pores are closed, and people begin to pant; they become boisterous and coarse and do not perspire. They become feverish, their mouths are dry and sore, their stomachs feel tight, and they die of constipation. When Yang is the stronger, people can endure winter but not summer. When Yin is the stronger, the body is cold and covered with perspiration. People realize they are ill; they tremble and feel chilly. When they feel chilled, their spirits become rebellious. Their stomachs can no longer digest food and they die. When Yin is the stronger, people can endure summer but not winter. Thus Yin and Yang alternate. Their ebbs and surges vary, and so does the character of their diseases."

The Yellow Emperor asked, "Can anything be done to harmonize and adjust these two principles of nature?"

Ch'i Po answered: "If one has the ability to know the seven injuries and the eight advantages, one can bring the two principles into harmony. If one does not know how to use this knowledge, his life will be doomed to early decay. By the age of forty the Yin force in the body has been reduced to one-half of its natural vigor, and an individual's youthful prowess has deteriorated. By the age of fifty the body has grown heavy. The ears no longer hear well. The eyes no longer see clearly. By the age of sixty the life-producing power of Yin has declined to a very low level.

"Those who seek wisdom beyond the natural limits will retain good hearing and clear vision. Their bodies will remain light and strong. Although they grow old in years, they will stay able-bodied and vigorous and be capable of governing to great advantage. For this reason the ancient sages did not rush into the affairs of the world. In their pleasures and joys they were dignified and tranquil. They did what they thought best and did not bend their will or ambition to achievement of empty ends. Thus their allotted span of life was without limit, like that of Heaven and Earth.

"By observing myself I learn about others, and their diseases become apparent to me. By observing the external symptoms, I gather knowledge about the internal diseases. One should watch for things out of the ordinary. One should observe minute and trifling things and treat them as if they were big and important. When they are treated, the danger they pose will be dissipated. Experts in examining patients judge their general appearance; they feel their pulse and determine whether it is Yin or Yang that causes the disease….To determine whether Yin or Yang predominates, one must be able to distinguish a light pulse of low tension from a hard, pounding one. With a disease of Yang, Yin predominates. With a disease of Yin, Yang predominates. When one is filled with vigor and strength, Yin and Yang are in proper harmony."

Medicine in Ancient Greece

According to G.E.R. Lloyd, a scholar of ancient Greece: "In Western medicine, the name of Hippocrates has always stood for an ideal. Until comparatively recently in the history of Western medical thought, his views—that is, the views of the works that passed for his—were accepted as authoritative on all kinds of medical problems, and medical students read their Hippocrates not out of piety but as an essential part of their training as doctors."[11] Although physicians trained in the West are generally not required to study the Hippocratic texts today, they still take the Hippocratic oath. Moreover, many of today's common medical terms, such as crisis, arthritis, asthma, hypochondria and tetanus, come from the ancient Greeks.

As the above quotation suggests, no one knows for sure whether the texts of the *Hippocratic Corpus* (about 60 in all) were actually written by the famous doctor Hippocrates, who lived between 460 and 380 BC. Hippocrates was one of the most influential thinkers of his day, and the *Hippocratic Corpus* is a classic text of Greek medicine. Probably the *Corpus* is the work of many medical writers, who reveal varying points of view. A hallmark of Greek medicine in Hippocrates' day was debate—over how diseases evolved, how they should be treated, and even the purposes of medicine itself. As you can see from this text, debate occurred not only among physicians, but between physicians and a sometimes skeptical public.

Hippocrates has been credited with giving physicians a special place in society and with bringing a strong ethical code to medical practice. Hippocratic medicine was increasingly based on observation but also relied on much complex theory, which was later rejected by modern physicians. Still, Hippocrates' work influenced generations of physicians and also influenced the development of Western science generally. By studying the body and the course of disease, the ancient Greeks learned much about physical causation generally, and about how organisms adapted to their environment. They also developed clinical observation and the practice of taking case histories, which would be used for generations to come.

The writings of Hippocrates and of the famous later Greek physician Galen (born in 129 AD) were studied in the Arab world and used to develop innovative knowledge and medical practice while Europe languished in its "Dark Ages" between Galen's day and the European Renaissance. European Renaissance writers would then revive the ancient Greeks' ideas and use them in their development of new scientific theories.

"The Science of Medicine," excerpted from* Hippocratic Corpus *(G.E.R. Lloyd, ed.,* Hippocratic Writings, *New York: Penguin Books, 1978, 139-149).

The Science of Medicine

Note: The term "science" should be loosely interpreted. Translators debate whether to translate the title of this text as "The Science of Medicine" or "The Art of Medicine."

Let us consider the science of medicine, since that is my own subject, by way of illustration. First of all I would define medicine as the complete removal of the distress of the sick, the alleviation of the more violent diseases and the refusal to undertake to cure cases in which the disease has already won the mastery, knowing that everything is not possible to medicine. It is my intention to prove that medicine does accomplish these things and is ever capable of doing them.

There are some too who condemn the science of medicine because doctors are unwilling to tackle incurable cases. They allege that such diseases as the physicians do attempt to treat would get better themselves in any case, while those that need medical attention are neglected. If medicine were really a science, they say, all should be cured alike....A man who thinks that a science can perform what is outside its province, or that nature can accomplish unnatural things, is guilty of ignorance more akin to madness than to lack of learning. Our practice is limited by the instruments made available by Nature or by Art. When a man is attacked by a disease more powerful than the instruments of medicine, it must not be expected that medicine should prove victorious.

Those who are reasonably proficient in the science of medicine can distinguish two classes of disease. There is a small group in which the signs are readily seen by the eye, those in which the flesh is changed in appearance or in which swellings are demonstrable. Then there is a large group not so easily diagnosed. In the former group, signs can be elicited by sight and touch, for instance, whether the skin be firm or clammy, hot or cold, and each of such signs is of significance.

There should be no difficulty, then, in the management of these obvious or external diseases, but the less obvious or internal diseases should not be wholly beyond the power of the science. In this latter group I include disease of the bones and of the cavities of the body. The body contains many hollow organs; there are two which receive and pass on the food and many others which those who have studied them will know. Every part of the body, which is covered with flesh or muscle contains a cavity. Every separate organ, whether covered by skin or muscle, is hollow, and in health is filled with life-giving spirit; in sickness it is pervaded by unhealthy humours. The arms, for example, possess such a cavity, as also do the thighs and legs. Even those parts which are relatively poorly covered with flesh contain such cavities. Thus the trunk is hollow and contains the liver, the skull contains the brain, and the thorax the lungs.

Since these diseases cannot be diagnosed by sight, I call them internal diseases and such is the term employed by the profession. These internal diseases have not been mastered, but they have been mastered as far as possible for the present.

If the nature of a disease cannot be perceived by the eye, its diagnosis will involve more trouble and certainly more time than if it can. What escapes our vision we must grasp by mental sight, and the physician, being unable to see the nature of the disease nor to be told of it, must have recourse to reasoning from the symptoms with which he is presented. Then when sick men suffer from delay in diagnosis, it is due rather to the nature of the disease and of the patient than to the failure of the physician.

But although neither deep abscesses nor diseases of the kidneys nor of the liver nor of other organs situated within the body are visible to the eye, which is the most satisfactory way of observation, medicine has none the less found out means by which a diagnosis may be reached. Such means consist of observations on the quality of the voice, whether it be clear or hoarse, on the respiratory rate, whether it be quickened or slowed, and on the constitution of the various fluids which flow from the orifices of the body, taking into account their smell and colour, as well as their thinness or viscosity. By weighing up the significance of these various signs it is possible to deduce of what disease they are the result, what has happened in the past and to prognosticate the future course of the malady. Even when nature herself does not produce such signs, they may be revealed by certain harmless measures known to those practiced in the science. Thus the physicians may determine what remedies should be applied. For instance, a patient may be made to rid himself of phlegm by the administration of certain acid draughts and foods. Thus a visible sign is produced of some underlying disease which could not otherwise be demonstrated to the sight. If a patient be made to walk uphill or to run, abnormalities in respiration will be observed which would not be apparent at rest. By producing sweating in the manner just mentioned the signs of fever can be observed, just as the steam from hot water indicates fire. Substances can be given which, excreted in the urine, or through the skin, reveal the disease better.

That the science of medicine makes use of principles which can be of real assistance has been shown in this work. But it would not be fair to expect medicine to attempt cures that are all but impossible, nor to be unfailing in its remedies.

Footnotes

[1] Pachuta, Donald M. "Chinese Medicine: The Law of Five Elements," in *Eastern and Western Approaches to Healing: Ancient Wisdom and Modern Knowledge*, Annees A. Sheikh and Katharina S. Sheikh, eds., New York: John Wiley and Sons, 1989, 65.

[2] Cromwell Crawford, "Ayurveda: The Science of Long Life in Contemporary Perspective," in *Eastern and Western Approaches to Healing*, 9.

[3] Crawford, "Ayurveda," 4.

[4] Jurgen Thorwald, *Science and Secrets of Early Medicine*, New York: Harcourt, Brace & World, Inc., 1962, 204..

[5] Thorwald, 205.

[6] Pachuta, "Chinese Medicine," 66.

[7] Temple, Robert, *The Genius of China: 3,000 Years of Science, Discovery, and Invention*, New York: Simon and Schuster, 1986, 123.

[8] Temple, 124.

[9] Majno, Guido, *The Healing Hand: Man and Wound in the Ancient World*, Cambridge, Mass.: Harvard University Press, 1975, 243.

[10] Majno, 242.

[11] G.E.R. Lloyd, ed., *Hippocratic Writings*, New York: Penguin Books, 1978.

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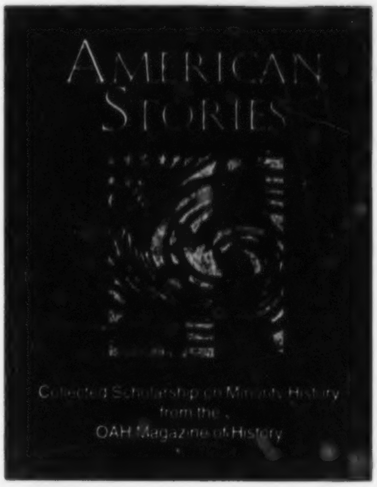
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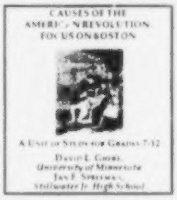
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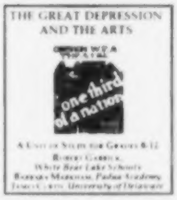
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TABLE OF CONTENTS

I. Program Overview

A. Themes ... 2
B. Topics ... 2
C. Rewards for Participation ... 2
D. Divisions ... 3
E. Contest Categories ... 3
F. Important Notices for Contestants ... 3
G. Program Materials ... 3

II. Rules for All Categories

A. General Rules ... 4
B. Required Written Materials for All Entries ... 5
C. Contest Participation ... 6

III. Category Rules

A. Papers ... 7
B. Exhibits ... 8
C. Performances ... 9
D. Documentaries ... 10

IV. How Will Your Entry Be Judged?

A. Who are the Judges? ... 12
B. How Does the Judging Process Work? ... 12
C. Consensus Judging ... 12
D. The Subjective Nature of Judging ... 12
E. The Decision of the Judges is Final ... 13
F. Judging Criteria ... 13
    1. Historical Quality
    2. Clarity of Presentation
    3. Relationship to Theme
G. Rule Compliance ... 14

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Through History Day you will learn the skills and techniques of the historian and will discover new insights. At the competitions you will have the opportunity to meet students from other schools, exchange ideas, and demonstrate the results of your work. Your success in researching and producing a History Day entry may even take you to the national contest held each June at the University of Maryland at College Park.

ABOUT THIS GUIDEBOOK

Before you begin work on your entry, you, your teacher, and your parents should carefully read this booklet. This guide contains rules that you must follow to compete in any level of the History Day competition. More information on topics, sources, and deadlines is available from your district and state History Day coordinators. Always contact your district or state coordinator to learn if any rules have been revised since publication of this guide.

Definitions

Historical Context:

The intellectual, physical, social, and cultural setting in which events take place.

Historical Perspective:

Understanding a topic's development over time and its influence in history.

Plagiarism:

Plagiarism is using the work or ideas of others in ways that give the impression that these are your own (e.g. copying information word-for-word without using quotations and footnotes, paraphrasing an author's ideas, or using visuals or music without giving proper credit.)

Primary Sources:

Primary sources are materials directly related to a topic by time or participation. These materials include letters, speeches, diaries, newspaper articles from the time, oral history interviews, documents, photographs, artifacts, or anything else that provides first-hand accounts about a person or event. An interview with an expert (a professor of Civil War history, for example) is not a primary source. Quotes from historical figures in secondary sources are not considered primary.

Secondary Sources:

Secondary sources are usually published books or articles by authors who base their interpretation on primary sources.

I. PROGRAM OVERVIEW

Notes

NOTE

You should ask questions about the topic's development over time and its impact in history. Your answers to such questions will help you draw conclusions about your topic's significance in history.

NOTE:

Students in non-graded schools must check with the National History Day office to determine in which division they should register for the competition.

A. Themes

Each year a broad theme is selected for the History Day contest. You may select a topic on any aspect of local, regional, national, or world history. **Regardless of the topic chosen, your presentation of your research and conclusions must clearly relate to the annual theme.** Be careful to limit the scope of your topic to make the research and interpretation of your topic manageable. In other words, narrow your topic to focus on an issue that can be explained and interpreted within the category limits of size and time.

B. Topics

Effective History Day entries not only describe an event or a development, they also analyze it and place it in its historical context. Ask yourself the following questions about your topic:

- How is my topic important?
- How was my topic significant in history in relation to the History Day theme?
- How did my topic develop over time?
- How did my topic influence history?
- How did the events and atmosphere (social, economic, political, and cultural aspects) of my topic's time period influence my topic in history?

C. Rewards for Participation

At each level of competition, outstanding achievement may be recognized through certificates, medals, trophies, or monetary awards. A number of special prizes may be given at the regional, state, or national level. The most important rewards are the skills and new knowledge that you will acquire as you move through the History Day program. Research, writing, and communication skills

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will be especially important if you plan to go to college and will help you no matter what direction your life takes.

D. Divisions

The National History Day competition has two divisions based on school grade:

Junior Division - grades 6, 7, and 8

Senior Division - grades 9, 10, 11, and 12.

Entries in each division are judged separately at all levels of competition.

E. Contest Categories

You may enter one of seven categories:

- paper (individual only)
- individual exhibit
- group exhibit
- individual performance
- group performance
- individual documentary
- group documentary

Each category in each division is judged separately. Groups may include 2 to 5 students. Group participants do not have to be in the same grade to compete together.

F. Important Notices for Contestants

All contests are held in public areas, and you are solely responsible for the security and safety of your own equipment and artifacts. History Day program officials and sponsors will not be responsible for the loss of or damage to exhibits, equipment, or personal belongings during the program activities.

G. Program Materials

Each year program materials such as topic suggestions and bibliographies are available upon request from National History Day to help teachers and students prepare for the contest. The materials may be duplicated for classroom use. For further information, contact your district or state coordinator or the National History Day office.

Notes

NOTE:

Some states sponsor participation in 4th and 5th grades at the state level. Check with your state coordinator for more information.

NOTE:

Choose a category in which you can make the best use of your own special abilities, talents, and interests. Be careful to choose the most suitable category in which to present your research and conclusions and take into consideration the availability of equipment and resources.

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II. RULES FOR ALL CATEGORIES

Notes

A. GENERAL RULES

Rule 1: *Annual Theme*

Your entry must be clearly related to the annual theme and explain your topic's significance in history.

Rule 2: *Contest Participation*

You may participate in the research, preparation, and presentation of **only one** entry each year.

Rule 3: *Individual or Group Entries*

A paper, individual exhibit, individual performance, or individual documentary must be the work of only one student. A group exhibit, group performance, or group documentary must be the work of 2 to 5 students. All students in a group entry must be involved in the research and interpretation of the group's topic.

Rule 4: *Development Requirements*

Entries submitted for competition must be researched and developed during the current contest year that begins following the national contest each June. **Revising or reusing an entry from a previous year—whether your own or another student's—is unacceptable and will result in disqualification.**

Rule 5: *Construction of Entry*

You are responsible for the research, design, and creation of your entry. You may receive help and advice from teachers and parents on the mechanical aspects of creating your entry: (1) you may have help typing your paper and other written materials; (2) you may seek guidance from your teachers as you research and analyze your material, but your conclusions must be your own; (3) you may have photographs and slides commercially developed; (4) you may have reasonable help cutting out your backboard (e.g. a parent uses a cutting tool to cut the board that you designed).

RULE 5 NOTE:

Objects created by others specifically for use in your entry violate this rule. For example, a parent takes photographs or an artist draws the backdrop for your exhibit or performance. You may receive reasonable help in carrying and placing props and exhibits.

Rule 6: *Supplying Equipment*

You are responsible for supplying all props and equipment at each level of competition. Projection screens for documentaries and performances **may** be provided if requested. Check with your contest coordinator about availability of equipment. Pianos are not provided. VCRs (VHS format only) and monitors are available at the national contest for the documentary category only.

RULE 6 NOTE:

Be prepared: bring extension cords if needed and check with your district and state coordinators about the availability of equipment.

Rule 7: *Discussion with Judges*

You should be prepared to answer judges' questions about the content and development of your entry, but you may not give a formal, prepared introduction, narration, or conclusion.

Rule 8: *Costumes*

You are not permitted to wear costumes that are related to the focus of your entry during judging, except in the performance category.

Rule 9: *Prohibited Materials*

Items potentially dangerous in any way—such as weapons, firearms, animals, organisms, plants, etc.—are strictly prohibited. Such items will be confiscated by security personnel or contest officials.

Rule 10: *Title*

Your entry must have a title that is clearly visible on all written materials.

B. REQUIRED WRITTEN MATERIALS FOR ALL ENTRIES

Rule 11: *Title Page*

A title page is required as the first page of written material in every category. Your title page **must include only** the title of your entry, your name(s) and the contest division and category in which you are entered.

Rule 12: *Annotated Bibliography*

An annotated bibliography is required for all categories. It should contain all sources that provided usable information or new perspectives in preparing your entry. You will look at many more sources than you actually use. **You should list only those sources that contributed to the development of your entry.** Sources of visual materials and oral interviews must be included. The annotations for each source must explain how the source was used and how it helped you understand your topic.

For example:

Bates, Daisy. *The Long Shadow of Little Rock.* New York:
David McKay Co. Inc., 1962.

Daisy Bates was the president of the Arkansas NAACP and the one who met and listened to the students each day. This first hand account was very important to my paper because it made me more aware of the feelings of the people involved.

Notes

RULE 7 NOTE

You should be prepared to explain the design, research, and creation of your entry if questioned by the judges. Judges need to know that your entry is your own work.

RULE 11 NOTE

The title page must not include any other information (pictures, graphics, borders, school name, or grade) except for that described in this rule.

RULE 12 NOTE

Oral history transcripts, correspondence between you and experts, questionnaires, and other primary or secondary materials used as sources for your entry should be cited in your bibliography but not included as attachments to your bibliography.

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Rule 13: *The Separation of Primary and Secondary Sources*

You are required to separate your bibliography into primary and secondary sources.

Notes

RULE 13 NOTE

Some sources may be considered as either primary or secondary. Use your annotations to explain your reasoning for classifying any sources that are not clearly primary or secondary.

Rule 14: *Style Guides*

Style for citations and bibliographic references must follow the principles in one of the following style guides: (1) Kate L. Turabian, *A Manual for Writers of Term Papers, Theses, and Dissertations* or (2) the style guide of the Modern Language Association of America (MLA). **Regardless of which manual you use, the style must be consistent throughout the paper.**

Rule 15: *Process Paper*

Entries in all categories except historical papers must include three copies of the following written materials: (1) A title page described in Rule 11. (2) A description of no more than 500 words explaining how you conducted your research and created and developed your entry. You must conclude your description with an explanation of the relationship of your topic to the contest theme. (3) An annotated bibliography described in Rule 12. **These materials must be typed or neatly printed on plain white paper and stapled together in the top left corner. Do not enclose them in a cover or binder.**

Rule 16: *Plagiarism*

You must acknowledge in your annotated bibliography all sources used in your entry. **Failure to credit sources is plagiarism and will result in disqualification.**

C. CONTEST PARTICIPATION

Rule 17: *Entry Procedure*

At each contest level you must submit a complete, accurate, and legible entry form and meet specific deadlines and procedures established by your contest coordinator.

Rule 18: *Entries to National Competition*

Each state is limited to no more than two entries per contest category in the national contest. Ties at state contests will be resolved at the state level.

Rule 19: *National Competition Attendance*

Individual students and groups must be present for an entry to be judged at the national contest.

III. CATEGORY RULES

A. PAPERS

A paper is the traditional form of presenting historical research. Various types of creative writing (for example, fictional diaries, poems, etc.) are permitted, but must conform to all general and category rules. Your paper should be grammatically correct and well written.

Part II, Rules for All Categories, (except for Rule 15), applies to papers.

Rule 1: *Length Requirements*

The text of historical papers must be no less than 1,500 and no more than 2,500 words in length. Notes, annotated bibliography, illustration captions, and supplemental/appendix material do not count in that total. Appendix material must be directly referred to in the text of the paper. Extensive supplemental materials are inappropriate.

Rule 2: *Citations*

Citations—footnotes, endnotes or internal documentation—are required. Citations are used to credit the sources of specific ideas as well as direct quotations. Refer to Part II, Rule 14, for citation styles.

Rule 3: *Preparation Requirements*

Papers must be typed, computer printed, or legibly handwritten in ink on plain, white 8.5 x 11-inch paper with 1-inch margins on all sides. Pages must be numbered consecutively and double-spaced with writing on one side and with no more than 12 characters per inch or no less than 10-point type. Papers must be stapled in the top left corner and should not be enclosed in any cover or binder. The title page should have no illustrations.

Rule 4: *Number of Copies*

Four copies of the paper must be submitted with the appropriate entry form **by the deadline** established for the contest. Winning papers are sometimes published by contest officials; you must be prepared to give permission for such publication.

Notes

RULE 1 NOTE

Oral history transcripts, correspondence between you and experts, questionnaires, and other primary or secondary materials used as sources for your paper should be cited in your bibliography but not included as attachments to your paper.

RULE 4 NOTE

Be sure to keep a copy of your paper for yourself and bring it with you to the contest.

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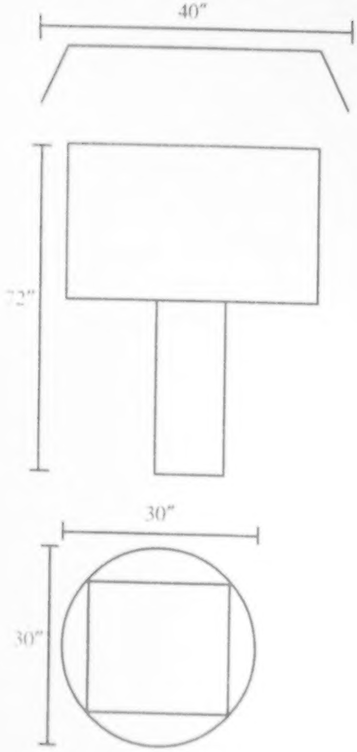
Notes

RULE 1 DIAGRAMS



RULE 2 NOTE

For example, a brief excerpt from a taped student-conducted oral interview or a dramatic reading might be appropriate, but taped commentary or analysis is inappropriate.

B. EXHIBITS

An exhibit is a visual representation of your research and interpretation of your topic's significance in history, much like a small museum exhibit. The analysis and interpretation of your topic must be clear and evident to the viewer. Labels and captions should be used creatively with visual images and objects to enhance the message of your exhibit.

Part II, Rules for All Categories, applies to exhibits.

Rule 1: *Size Requirements*

The overall size of your exhibit when displayed for judging must be no larger than 40 inches wide, 30 inches deep, and 6 feet high. Measurement of the exhibit does not include the table on which it rests; however, it would include any stand that you create and any table drapes. Circular or rotating exhibits must be no more than 30 inches in diameter.

Rule 2: *Media Devices*

Media devices (e.g., tape recorders, projectors, video monitors, computers) used in an exhibit must not run for more than a total of 3 minutes. Viewers and judges must be able to control media devices. Any media devices used must fit within the size limits of the exhibit. Any media devices used should be integral to the exhibit—not just a device to bypass the prohibition against live student involvement.

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Rule 3: *Word Limit*

Student-composed written materials that are used on an exhibit (excluding the title page, process paper, and annotated bibliography) must contain no more than 500 words. This limit does not apply to documents, oral history quotations, artifacts with writing, or other illustrative materials that are used as an integral part of the exhibit. The 500 word limit includes student-composed written materials used in any media devices (computers, slides, video) and/or any supplemental materials.

Notes

RULE 3 NOTE

Be careful that your message is clear and contained on the exhibit itself; judges have little time to review supplemental material. Extensive supplemental material is inappropriate. For example, oral history transcripts, correspondence between you and experts, questionnaires, and other primary or secondary materials used as sources for your exhibit should be cited in your bibliography but not included as attachments to your bibliography or exhibit.

C. PERFORMANCES

A performance is a dramatic portrayal of your topic's significance in history and must be original in production.

Part II, Rules for All Categories, applies to performances.

Rule 1: *Time Requirements*

Performances may not exceed 10 minutes in length. Timing starts at the beginning of the performance following the announcement of the title and student names. Any other introductory remarks will be considered part of the performance and will be counted as part of the overall time. You will be allowed an additional 5 minutes to set up and 5 minutes to remove any props needed for your performance.

RULE 1 NOTE

You should allow several empty seconds in your performance to account for unplanned pauses (e.g. applause, forgotten lines, etc.).

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Notes

Rule 2: *Performance Introduction*

The title of your entry and the names of the participants must be the first and only announcements prior to the start of the performance.

Rule 3: *Media Devices*

Use of slides, tape recorders, computers, or other media within your performance is permitted. You must run all equipment and carry out any special lighting effects.

Rule 4: *Script*

The script for the performance should **not** be included with the written material presented to the judges.

D. DOCUMENTARIES

A documentary should reflect your ability to use audiovisual equipment to communicate your topic's significance, much as professional documentaries do. The documentary category will help you develop skills in using photographs, film, video, audio tapes, and graphic presentations. Your presentation should include primary materials but must also be an original production. To produce a documentary you must have access to equipment and be able to operate it.

Part II, Rules for All Categories, applies to documentaries.

Rule 1: *Time Requirements*

Documentaries may not exceed 10 minutes in length. You will be allowed an additional 5 minutes to set up and 5 minutes to remove equipment. Timing will begin when the first visual image of the presentation appears and/or the first sound is heard. Color bars and other visual leads in a video will be counted in the time limit.

RULE 1 NOTE

Use your set-up time to focus slides, etc.

Rule 2: *Introduction*

You must announce only the title of your presentation and names of participants. **Live narration or comments prior to or during the presentation are prohibited.**

Notes

Rule 3: *Student Involvement*

You are responsible for running all equipment and carrying out any special lighting effects.

Rule 4: *Student Involvement and Production*

All entries must be student-produced. You must operate all equipment. You must provide the narration, voice-overs and dramatization.

Rule 5: *Entry Production*

Your entry must be an original production. You may use professional photographs, film, slides, recorded music, etc. within your presentation. However, you must integrate such items into your presentation and give proper credit within the presentation as well as in your annotated bibliography. Slides may be professionally developed. You must operate all editing equipment used in the production of your presentation.

Rule 6: *Displays*

Added exhibits of visual or written material are not allowed.

Rule 7: *Computer Entries*

A student-composed computer program is an acceptable entry. You must be able to run the program within the 10 minute time limit. Interactive computer programs and web pages in which the audience or judges are asked to participate are not acceptable; judges are not permitted to participate in your presentation by operating any equipment.

IV. HOW WILL YOUR ENTRY BE JUDGED?

Notes

A. WHO ARE THE JUDGES?

Historians, educators, and others interested in history and education serve as judges at each level of the History Day competition.

B. HOW DOES THE JUDGING PROCESS WORK?

Each separate History Day division and category is usually judged as a whole by a team of three judges. Time constraints, due to the number of entries, often require that some categories must be judged initially by several teams of judges. Run-offs then become necessary. In such cases, the entries judged best by each team of initial judges are re-judged by a new team of judges to determine the winning entries in the category. The number of entries in run-offs and procedures for run-off judging vary by contests and categories and are totally within the discretion of the contest officials.

Judges are strongly encouraged to question students and to write comments on the judging forms.

C. CONSENSUS JUDGING

Judges will not assign a numerical score to each entry, but will rank the entries in their group. Judges are required to consult with each other in determining individual rankings. Judges are allowed to review the results of their category upon completion of the judging in order to assure accuracy of the judging process. As a final step, the judges will assign each entry an overall rating.

D. THE SUBJECTIVE NATURE OF JUDGING

Remember: judges must evaluate certain aspects of your entry that are objective (e.g., were primary sources used; is the written material grammatical and correctly spelled). But judges must also evaluate interpretive aspects of your entry which are qualitative in nature (e.g., analysis and conclusions about the historical data).

Historians often reach different opinions about the significance of the same data. It is therefore crucial for you to base your interpretations and conclusions on solid research. Judges will check to determine whether you used available primary sources and if you were careful to examine all sides of an issue and present a balanced account of your research and presentation. Your process paper and annotated bibliography are critical to this process.

NOTE

Remember, you must explain your topic's significance in history.

E. THE DECISION OF THE JUDGES IS FINAL

You, your parents, and your teachers should realize that inadvertent inequities may occur in judging and that contest officials do want to be informed of any problems. But the decisions of the judges are final.

F. JUDGING CRITERIA

Historical Quality (60%)

The most important aspect of your entry is its historical quality. You should ask yourself the following questions to help you focus on your historical analysis:

- Is my entry historically accurate?
- Does my entry provide analysis and interpretation of the historical data rather than just a description?
- Does my entry demonstrate an understanding of the historical context?
- Does my annotated bibliography demonstrate wide research?
- Does my entry demonstrate a balanced presentation of materials?
- Does my entry demonstrate use of available primary sources?

Clarity of Presentation (20%)

Although historical quality is most important, your entry must be presented in an effective manner. You should ask yourself the following questions to help you focus on your presentation:

- Is my entry original, creative, and imaginative in subject and presentation?
- Is my written material clear, grammatical, and correctly spelled?
- Do I display stage presence in a performance?
- Is the visual material I present clear?
- Do I understand and properly use all my equipment?

Relationship to Theme (20%)

Your entry must clearly explain the relation of your topic to the annual History Day theme. You should ask yourself the following questions to help you focus your topic on the theme and its significance:

Notes

Notes

- How does my topic relate to the theme? Why is my topic important?
- How is my topic significant in history in relation to the History Day theme?
- How did my topic influence history?
- How did the events and atmosphere (social, economic, political, and cultural aspects) of my topic's time period influence my topic in history?

G. RULE COMPLIANCE

Judges will take into consideration in their final rankings any rule infraction. Failure to comply with the rules will count against your entry. Rule infractions should be corrected before a winning entry competes in the next level of competition.

CATEGORY CHECKLIST

Exhibit Category

Individual and Group (2-5 students)

- No larger than 40 inches wide, 30 inches deep, and 6 feet high when displayed
- 3 copies (plus one for you) of written materials: title page with required information; 500 word description of the research methods used (a judging team may retain one copy for review)
- Annotated bibliography, separated into primary and secondary sources
- Exhibit addresses the theme
- Title is clear and visible
- Labels, captions, and titles include no more than 500 words
- Has visual impact and shows interpretation
- Names and addresses of all group participants listed on entry card
- Entry card and fee mailed by deadline
- Prepared to answer judges' questions at the contest (remember that formal narratives are not appropriate responses to questions)

Performance Category

Individual and Group (2-5 students)

- 10 minute maximum for performance
- Maximum 5 minutes to set up and 5 minutes to take down
- 3 copies (plus one for you) of written materials: title page with required information; 500 word description of the research methods used (a judging team may retain one copy for review)
- Annotated bibliography, separated into primary and secondary sources
- Performance addresses the theme
- All props and equipment are student supplied
- Only student entrants run equipment and are involved in the performance
- Extra supplies and materials in case of emergency
- Names and addresses of all group participants listed on entry card
- Entry card and fee mailed by deadline
- Prepared to answer judges' questions at the contest (remember that formal narratives are not appropriate responses to questions)

Documentary Category

Individual and Group (2-5 students)

- 10 minute maximum for presentation
- Maximum 5 minutes to set up and 5 minutes to take down
- 3 copies (plus one for you) of written materials: title page with required information; 500 word description of the research methods used (a judging team may retain one copy for review)
- Annotated bibliography, separated into primary and secondary sources
- Documentary addresses the theme
- Live student involvement limited to giving name and title and operating equipment
- Names and addresses of all group participants listed on entry card
- Entry card and fee mailed by deadline
- Extra supplies and materials in case of emergency
- Prepared to answer judges' questions at the contest (remember that formal narratives are not appropriate responses to questions)

Historical Paper Category

Individual Only

- 1,500-2,500 words, excluding notes, annotated bibliography, and title page
- Title page with only the required information
- Annotated bibliography, separated into primary and secondary sources
- Paper addresses the theme
- Citations
- 4 copies (plus one for you)
- Organization shows clear focus and progression
- Entry card, papers, and fee mailed by deadline
- Prepared to answer judges' questions at the contest (remember that formal narratives are not appropriate responses to questions)

for further information
contact

NATIONAL HISTORY DAY

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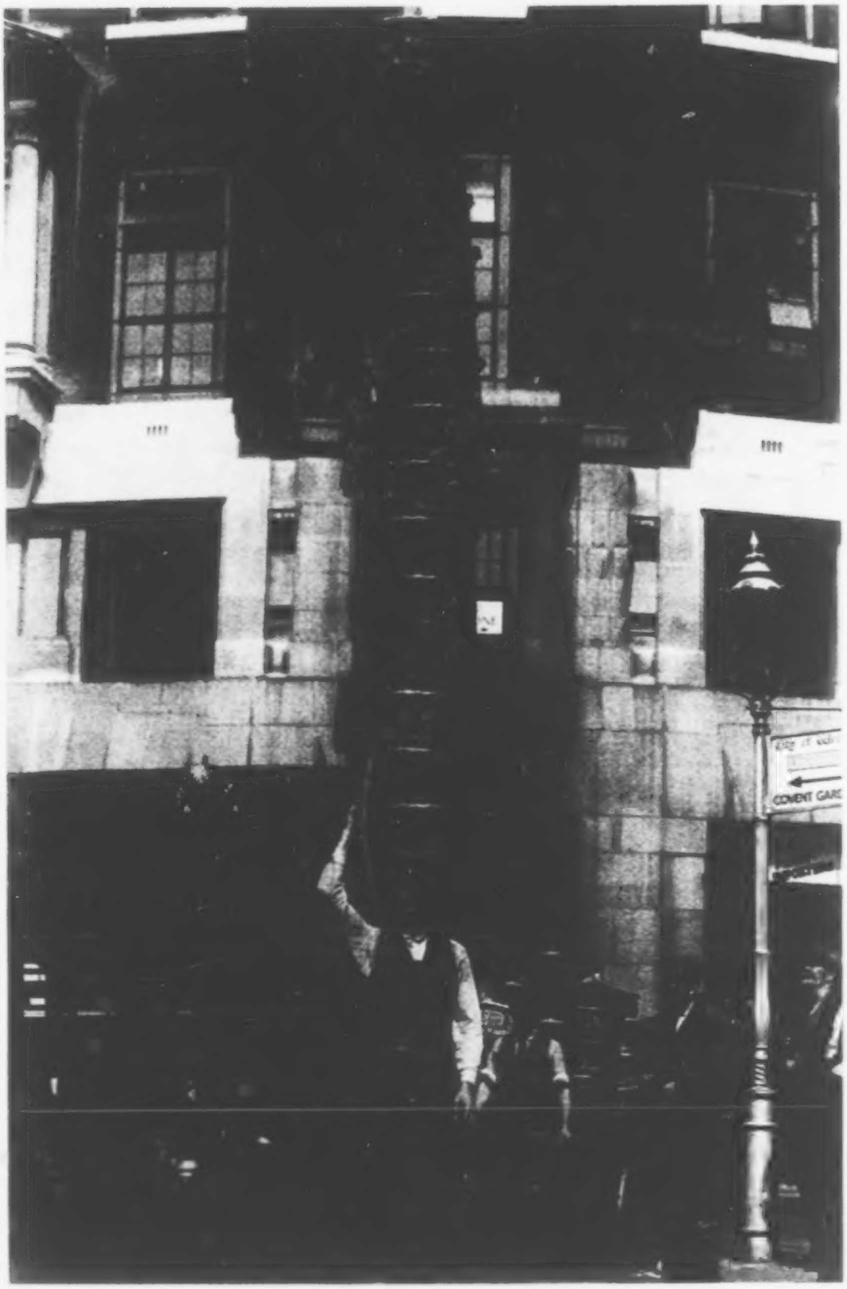

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